CONTROL AND REDUCTION OF ARMAMENTS

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HEARINGS

BEFORE A

SUBCOMMITTEE OF THE
COMMITTEE ON FOREIGN RELATIONS
UNITED STATES SENATE

EIGHTY-FIFTH CONGRESS

SECOND SESSION

(Pursuant to S. Res. 93, S. Res. 185, and S. Res. 286, 84th Cong., and S. Res. 61, and S. Res. 241, 85th Cong.)

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WASHINGTON, D. C.

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CONTROL AND REDUCTION OF ARMAMENTS

FRIDAY, FEBRUARY 28, 1958

UNITED STATES SENATE,
SUBCOMMITTEE ON DISARMAMENT OF THE
COMMITTEE ON FOREIGN RELATIONS,
Washington, D. C.

The subcommittee met, pursuant to call, at 10:10 a. m., in room 318, Senate Office Building, Senator Hubert H. Humphrey (chairman of the subcommittee) presiding.

Present: Senators Humphrey (chairman), Green, Sparkman, Pastore, Saltonstall, and Aiken.

OPENING REMARKS OF THE CHAIRMAN

Senator HUMPHREY. We will call the subcommittee to order.

Today opens a series of hearings by the Subcommittee on Disarmament.

Our witness, as you know, is Mr. Harold Stassen, the former special assistant to the President for disarmament. The purpose of these hearings is to clarify for members of the subcommittee several of the key problems in our effort to achieve some workable and effective measure or measures to curb the present armaments race among the major powers.

If we cannot soon obtain some curtailment of the arms race, it is generally agreed that the future of all mankind is in great peril.

We have witnessed in the last few months several important developments which affect this matter of disarmament.

These developments are both political and technological, and it is the intent of the subcommittee to review these developments and analyze them to the best of our ability so that we may know how best they can be made to serve our goal of world peace.

INTRODUCTION OF MR. HAROLD E. STASSEN

As I indicated earlier, our witness today is the former special assistant to the President for disarmament, Mr. Harold Stassen.

Mr. Stassen has been asked to testify on his experiences as the principal United States negotiator in disarmament discussions and negotiations for the past 3 years. He is now a private citizen and in that capacity we earnestly hope to have the benefit of his views.

Mr. Stassen indicated to me in private conversation that he had no particular prepared statement; that he was prepared, however, to answer questions, and I indicated to him the outline of what I thought might develop in the hearing. First of all, we would like to receive from Mr. Stassen some of his observations in brief on the London

discussions in which he played the chief role for our country and the NATO powers, and also any comment that he might have relating to the discussions and negotiations at the United Nations.

But more important, it seems to me, are your views, Mr. Stassen, as to the future. The press, radio and television, have told us in rather elaborate detail what happened at London and the disappointments that ultimately followed, and of course we know of the Soviets' intransigence at the United Nations, and their walking out of the disarmament discussions, at least temporarily.

What we want to hear from you during this morning's hour are your views, your opinions as a result of your experience concerning the future, and the methods and the means that we might pursue as well as the objectives that we might have. With that as a background, Mr. Stassen, would you please first give us any analysis or statement that you might like to present relating to your work at London and at the United Nations.

Of course, this is a public session. We realize that there are certain materials that are not available for public sessions, but I think you can give us some guidance there.

Why don't you proceed on your own.

STATEMENT OF HAROLD E. STASSEN, FORMER SPECIAL ASSISTANT TO THE PRESIDENT

Mr. STASSEN. Mr. Chairman and gentlemen of the committee, I appear in response to your telegram of February 24, inviting me to appear, and I am willing to endeavor to cooperate with the committee in this matter.

I do not have a prepared statement, but I am willing to respond to the extent that I can do so to your questions.

LONDON DISARMAMENT NEGOTIATIONS

So far as your opening question is concerned, as to some observations on the London negotiations, and as to the developments from this point forward, let me first be very brief in this informal response to that question.

In the London negotiations in 1957 significant progress was made toward a first step agreement between the Soviet Union of Russia and the United States of America and the NATO and other associated states.

I think the fact that progress was made toward a first step agreement is quite generally conceded in all governments around the world.

FIRST STEP AGREEMENT

It is my view that it is very important that the world now move forward from that progress into a first step agreement for armaments control and the beginning of further moves toward lessening the danger of future wars and forming a sounder foundation for a lasting peace. It is my view that the United States of America and the Soviet Union can and should, in the months immediately ahead, move into a first step agreement which would consist of four parts.

First, the establishment of a United Nations agency or commission with the responsibility of supervising and inspecting the substance of all subsequent agreements that are reached.

Second, an agreement to open up mutually on both sides to the establishment of the necessary inspection stations to monitor and assure a cessation of nuclear testing. These inspection stations would require approximately 11 or 12 within the territory of the Soviet Union, an even number in the territories of the United States, both continental and extracontinental, and these inspection stations should be equipped with the essential scientific instruments which are seismic, acoustic, electromagnetic, and radiation measuring in their nature, and be manned by competent personnel under the United Nations agency that I referred to as the first part.

Third, the United States and the Soviet Union should agree that upon the ratification of a first step treaty by the United States Senate and by the Supreme Soviet, all nuclear testing by either one of them would be stopped for a 2-year trial period.

Fourth, that during this 2-year period, while this United Nations commission began to function, while the inspection stations were being installed in the Soviet Union, and while the tests of the two major powers, the nuclear tests, were stopped, the negotiations should then proceed effectively and continuously for working out the following steps.

It is my view that not only could such a first step be negotiated in the immediate future, but it would have the support of the NATO nations and perhaps I should clarify that in my views upon it because it is a very important matter to the United States.

INTEREST OF NATO COUNTRIES

Senator HUMPHREY. Mr. Stassen, at that point if you do not mind the interruption, the support of the NATO nations is particularly significant because I believe it was either yesterday or the day before that the President referred to the possibility that breaking up the so-called disarmament package into steps such as you have outlined here would or could run into opposition from the NATO countries.

We are in close alliance, of course, with our friends in Western Europe, and the agreements which we would have to work out would be in conjunction with them. Is it your view that the proposal which you are outlining would have the support of NATO countries?

Mr. STASSEN. Yes, and let me elaborate. As you observed, this is a very important item in the United States policy, this matter of the NATO view. You will find that in the statement the President made in a press conference last June 1957, a statement on his part very much along the lines of the four-part first move that I have just presented to the committee, and I believe the statement the President made in June of 1957 was sound and was wise, and I believe it is the first step that should now be taken in the interests of the United States and in fact in the mutual interests of the people of Russia and of all nations.

Now then, it would appear, as you said, from the last President's press conference, that he had been informed that the NATO countries

would not support that first step. I feel quite certain that the NATO countries will support that first step, and this becomes one of the most important items of foreign policy at the present moment.

CANADA

First of all, take Canada, a very important member of NATO and our immediate neighbor to the north. The Prime Minister of Canada and the head of the now opposition party in Canada—Canada having two major political parties, as you know—have both expressed themselves publicly on the importance of moving on a first step that was of a more limited and manageable nature than the complete inseparable package which was presented on August 29 in London, and the entire trend of the discussions in the Canadian Parliament and the public statement by Prime Minister Diefenbaker and Mr. Lester Pearson, in my view, clearly indicate that the Government of Canada would be inclined to support a first-step agreement consisting of the four parts that I mentioned if the Soviet Union and the United States reached such an agreement in consultation with the Government of Canada.

NORWAY

Secondly, the Government of Norway is an important member of NATO on the northern reaches and in close neighborhood to the Soviet Union, and has had a long friendly association with the United States.

The Government of Norway in the Parliament and on the part of the Prime Minister and the Foreign Minister have repeatedly expressed views that I interpret to be along the lines of favoring a first-step agreement of this limited but very significant nature that I have presented today. And I believe that, if the Soviet Union and the United States reached agreement on such a first step, the Government of Norway would not only approve it but would acclaim it.

GREAT BRITAIN

Take the United Kingdom of Great Britain. Here, of course, is one of the most important matters. There have been a number of declarations by Prime Minister Macmillan and by the leaders of the other party in Great Britain and seeking to move in a first step. But here comes one of the important areas where there seems to be a need of a clear definition of what I am recommending for a first step. The first step that I recommend would involve this commitment under inspection of the Soviet Union and the United States to temporarily cease as a trial basis all nuclear testing for 2 years.

I do not consider it essential for such a first step to be successful to have any other nation commit itself immediately to stop nuclear testing. That is a matter of an individual sovereign decision of other nations. It is essential that the NATO allies approve our abstention for 2 years and our joining in this initial inspection. It is not necessary that they each take the same commitment unless they wish to. And it may well be that the United Kingdom, that has not performed anywhere near the amount of nuclear testing that the Soviet Union and the United States have performed, may wish to conduct a few

more tests before they stop, or they may decide to suspend for 2 years along with us.

Whichever decision they make, in my view, does not militate against the importance of the two powers who are way out in front in nuclear matters and have these tremendous nuclear arms doing the first move of opening up on each side and suspending testing for 2 years while the negotiations proceed. And on that basis I feel quite certain that the Government of the United Kingdom would approve such a first step, would join in the United Nations Commission, would furnish some of her technical personnel to develop the scientific inspection services under the United Nations.

DENMARK

You take Denmark, another one of the NATO members. There have been many statements of the Government and Prime Minister which to me indicate that they would approve a step of this kind.

BELGIUM

Belgium, the Foreign Minister has indicated extreme concern with where we are headed now if we go on with a nuclear arms race without any beginning of inspection and control, and the indications are that the Government of Belgium would approve such a first step between the Soviet Union and the United States.

FRANCE

The Government of France is another special situation. France, as is publicly known, has been doing some research in the nuclear weapons field. It may be that the Government of France in its own sovereign decision would decide it would like to set off its first trial experiment before it agreed to stop and abstain.

I think that is an understandable position and that does not militate against the success of a first abstention for 2 years' trial between the Soviet Union and the United States. Or the Government of France may decide as a sovereign country that it would postpone the setting off of its first explosion for this 2 years while it found out whether the 2 years could lead to something more significant between the Soviet Union and the United States. I feel quite certain if the question is presented to the Government of France, whether it will approve the beginning of opening up of inspection of the Soviet Union and the United States and those two powers that are far out ahead and have conducted so many nuclear tests, suspending for 2 years, that the Government of France would approve of it.

SUSPENSION OF NUCLEAR WEAPONS TESTS

Senator HUMPHREY. Senator Pastore wanted to ask you a question.

Senator PASTORE. On this very point I am seeking to follow you very closely. This 2-year trial abstention would necessitate a third or fourth nation joining in what is essentially a bilateral agreement between the United States and the Soviet Union.

Mr. STASSEN. Senator, it is a multilateral agreement in which all participate in the United Nations decision, the Commission, the inspection of the 2, but it is the 2 who are the most powerful who are far ahead in the nuclear weapons and have tremendous destructive capability in their armaments now, those are the 2 who would make the first suspension, you see.

Senator PASTORE. Let that be as it may. Has there been any indication, on the part either of the United Kingdom or of France, that they would not be willing to join in this abstention or would hesitate to join themselves to this agreement between the United States and the Soviet Union so that all parties would cease all testing for a period of 2 years. Although these nations—No. 2, 3, and so on—may not have achieved in the development of nuclear and thermonuclear weapons, a competence comparable to the Soviet Union and ourselves, nevertheless I think that psychologically and for the benefit of mankind, it would be much better for all nations to join completely in this agreement. Therefore, I am asking you specifically if there have been any indications or intimations on the part of the United Kingdom or of France of an unwillingness to join fully in such agreement as could be struck between the United States and the Soviet Union.

Mr. STASSEN. Let me reemphasize that I think it is important to narrow and clarify the issue, and that these sovereign decisions as to what they do with their programs during the 2 years' suspension on the part of the United Kingdom and France I do not consider of the essence of the problem, and therefore, I do not endeavor to anticipate on that part of the problem which way their sovereign decisions will go.

As I say, they may both decide that they would also suspend for the 2 years, or they may decide that they would join in approving and participating in the Soviet Union and United States suspension, but themselves would want to remain free if they wanted to do another experiment or two, you see.

Senator PASTORE. I realize fully the considerations that move you but I wish to bring my own understanding up to date. You have said that tremendous progress was made in achieving a first-step agreement at the last London conference. Now, Great Britain and France did participate in that conference and its progress toward a first-step agreement, an integral part of which would be a 2-year cessation of tests on the part of the United States and of Russia.

Mr. STASSEN. That is right.

Senator PASTORE. Now, I am not saying that it becomes absolutely necessary, for the full efficacy of your plan, to have the United Kingdom and to have France join in toto. I realize that completely. All that I am asking is this—has there been any intimation on the part of the United Kingdom and of France that they would not join completely in this agreement—the cessation of tests. I realize that they have a sovereign right not to go along and their failure might not impair a pretty good cessation agreement. First of all, of course, there is a question of how much these nations have achieved in this nuclear direction. But I am not so much concerned with present or future abilities as I am with present attitudes. I am trying to learn the present attitude of Great Britain and of France—if, indeed, that attitude has been in evidence—whether it is a matter merely of giving their consent to cessation by two other nations—or whether they are

of a mind to contribute their own cessation of tests to achieve a common goal. Again, I do not say this in any spirit of criticism but to learn the state of mind of our allies if they have expressed it or if we have been able to fathom it.

Mr. STASSEN. You understand that this particular limited first step just comes out into public discussion in these last few days. In other words, all of this discussion publicly before had tended to be in terms of a package that had about seven inseparable parts, and therefore the issue was not focused down. I feel the possible important thing to our country and to the world is to now focus this issue clearly and precisely on the kind of a step that could and should be made in the interests of getting control of these modern armaments.

And let me at a later point come back to further clarification of the matter you raised, Senator. Let me continue the NATO countries right now.

ELIMINATION OF CUTOFF OF PRODUCTION OF FISSIONABLE MATERIAL AS PART OF FIRST STEP

Senator HUMPHREY. Mr. Stassen, before you do that, I think that there are two obvious questions which arise, since you have gone even beyond what the NATO countries themselves would approve or disapprove.

No. 1, as you recall, our proposal to stop nuclear testing was tied in with the cutoff on production of fissionable materials in the western package. Now, sometime in today's discussion, I want you to give us an answer as to whether or not this provision for the cutoff of fissionable materials has been separated from the proposal that you now make, namely, the so-called first step on a ban of nuclear testing for a 2-year trial period with inspection machinery as you have outlined, and whether or not you made this proposal prior to leaving your post?

Mr. STASSEN. The present United States position that was advanced on August 29, 1957, has really seven parts that were put up as inseparable, and it was in that inseparable position that it was not possible to negotiate agreement.

I think that this matter of the NATO nations' attitude on this more limited first step is so much of the essence of the foreign policy question that I will develop that a bit further first and come back to your questions, Senator, if I may.

Senator HUMPHREY. You understand my question.

Mr. STASSEN. I understand.

Senator HUMPHREY. My question is simply, did you, before you left the post that you recently held, recommend officially within the confines of the administration, Security Council, or the State Department, or did you recommend to the President, the type of first step that you are now suggesting, and did you recommend it as a separate item exclusive of the cutoff on nuclear materials production which was a part of our overall package. That is No. 1.

Mr. STASSEN. Right; I will come to that in this form.

Senator HUMPHREY. If you want to complete your NATO analysis, go right ahead.

Mr. STASSEN. Yes; I would like to do that and come back to your question.

Senator HUMPHREY. Thank you.

GERMANY

Mr. STASSEN. In the Federal Republic of Germany, obviously one of the key members of NATO, actually the Bundesrat in May 1957, passed a practically unanimous resolution supported by Chancelor Adenauer's party urging this beginning cessation of nuclear testing by the great powers. So I feel that they are on record, and I have seen no indication of any change on their part, that they would approve the kind of a limited first step that I am recommending this morning.

ITALY

The Government of Italy—there have been many public statements of the importance of getting a beginning cessation of nuclear testing, and I believe they would approve the Soviet Union and the United States making such a beginning. And of course many of the men of great leadership in the world, including his Holiness, the Pope, have issued encyclicals or statements at times at Christmas and Easter indicating the importance of mankind trying to make a move of this kind in the interests of decreasing the danger of war and Dr. Albert Schweitzer, the great philosopher, and many others who stand in a very significant position not only toward NATO but toward the world.

OTHER NATO COUNTRIES

Now in the instance of the other NATO countries, Portugal and Greece and Turkey, they are not involved so much in nuclear research or in this issue like these countries we have been talking about.

I have seen no indication that they would do other than in their own sovereign decision join in a United Nations support of a first move, if the United States and the Soviet Union reached agreement upon it, and if these other NATO countries in the center of Europe, like Germany and France and the United Kingdom had approved.

Now coming to your question, I do not consider that it is proper or right for me to give anything as to my recommendations at a time when I was in the administration or as to the consideration of those recommendations at that time. I think that part of my negotiations which became a matter of public record I can discuss with you, and I think I am free and I made it clear in the exchange of correspondence with the President that I of course as a citizen can now speak of what I believe the future policy and future moves should be.

Therefore, I place my recommendations on the basis of the studies and knowledge that I have as to where our country and the other countries should move from this point forward, and decline to go into internal administrative matters prior to my becoming a private citizen.

Senator HUMPHREY. Mr. Stassen, I want to yield to Senator Saltonstall on this matter, but I want to come back to this because we are discussing a matter of the greatest public importance, and I do feel that we have got to have an open and very frank discussion about it.

Go ahead, Senator.

Mr. STASSEN. I will discuss it very frankly, Senator, within the limits of what I consider to be the proper conduct.

Senator HUMPHREY. Thank you.

EFFECT UPON UNITED STATES SECURITY OF TEST SUSPENSION AGREEMENT

Senator SALTONSTALL. Mr. Stassen, my question is this. You stated to Senator Pastore that this would be a multilateral agreement or treaty rather than a bilateral agreement or treaty.

Now do I understand that you propose a multilateral treaty signed by all the United Nations or by all the NATO countries and that would affect the United States and Russia alone? That is what it amounts to, does it not?

Mr. STASSEN. It affects them all because of course they are all affected by what the Soviet Union and the United States do, and they are all affected by participating in the establishment of the United Nations regulatory agency and of providing personnel to begin establishing the inspection posts and the scientific instruments on both sides.

Senator SALTONSTALL. But primarily it would require action or cessation of action by two countries alone, Russia and the United States.

Mr. STASSEN. That is right, because these are the two that are way out ahead in nuclear weapon research and each has a devastating capability of destruction now in their arsenals.

Senator SALTONSTALL. So what it definitely comes down to, is that we have now signed, of course, the NATO agreement that will affect our security. But this would go even one step further and would be an agreement that would make us give up something that might affect our own security here in the United States, would it not?

Mr. STASSEN. Yes, and it is my view that such a first step agreement would improve our security in the United States and in Russia.

In other words, I do not consider that an all-out arms race without opening up inspection and beginning control is a road to security.

I think it is a road that carries in it great dangers of war in future years as these weapons become capable of more and more rapid delivery, and that the best approach for security and peace is to begin to open up on both sides to inspection and begin to get control of these weapons.

Senator SALTONSTALL. But what it would amount to would be to ask the Senate of the United States to consent to a treaty that would give up one of our weapons that we consider today necessary for our security.

Mr. STASSEN. You would give up no weapons, Senator.

Senator SALTONSTALL. You would give up the testing?

Mr. STASSEN. What is that?

Senator SALTONSTALL. You would give up the testing of weapons?

Mr. STASSEN. For 2 years you would agree that you would not test weapons after you ratified the treaty, provided at the same time the Soviet Union did not test weapons and they opened up to the inspection posts, which as I say would require 11 or 12 of them spaced around the Soviet Union, with scientific instruments so that you began to get control of this armaments situation.

It is my view that the United States will be more secure under that agreement than they will be in those 2 years in the absence of any agreement.

RUGULATORY COMMISSION AND INSPECTION POSTS

Senator SALTONSTALL. Would it be the responsibility of the United States to provide the expense, provide the money for the testing stations in its country and Russia in its country?

Mr. STASSEN. No. I feel that it should be shared; the expense should be shared by the whole United Nations who establish the inspection posts, perhaps on a proportionate basis the same as the United Nations itself is supported.

In other words, all nations should join in the support of the United Nations regulatory commission and in establishing these inspection posts and scientific instruments.

Senator SALTONSTALL. The multilateral agreement would be signed by all the United Nations countries.

Mr. STASSEN. It would be opened by the whole United Nations, and it would be a UN decision to set up the Commission and the treaty would provide who are the essential states to ratify before it goes into operation.

Of course, the essential ones to ratify would include the Soviet Union and the United States, would include the other principal NATO countries, and you would set up a certain number that must ratify before the Commission would begin to function.

Senator SALTONSTALL. And as I say, then all the nations that signed that agreement would have to be willing to put up their share of the expense.

Mr. STASSEN. That is right, and to cooperate in the recruitment of the necessary scientific personnel to man the inspection stations and to join in the negotiations for the succeeding steps, the succeeding steps of course being to expand the agreement, to affect other matters, and to directly put restrictions on other nations.

Senator SALTONSTALL. And under the United Nations charter, that would have to be approved by the United Nations Security Council, would it not?

Mr. STASSEN. Right.

Senator SALTONSTALL. Under the charter, the assembly has not the power to do that.

Mr. STASSEN. That is right.

In fact, under article 26 of the charter this matter of the regulation of armaments is placed under the Security Council.

Senator SALTONSTALL. So that the first agreement would be an agreement by the Security Council which would then go out to all the United Nations.

RATIFICATION OF AGREEMENT

Mr. STASSEN Yes.

I think it would be acceptable and reasonable to require that all members of the Security Council must ratify the treaty before it became operative, and that the other members of the United Nations could ratify as soon as they wished.

Senator SALTONSTALL. And before the United States, our country shared in that agreement, it would certainly have to be ratified by the United States Senate.

Mr. STASSEN. It would have to be ratified by a two-thirds vote of the United States Senate, and when thus ratified, on that day nuclear testing would stop for 2 years, and on that day you would begin moving in with the scientific instruments and set up these inspection stations geographically located both in Russia and the United States.

Senator SALTONSTALL. But, assuming both the United States and Russia signed it, it would not become effective until all these other nations signed it, would it?

Mr. STASSEN. I suggest as a minimum the members of the Security Council, and it is my view that if the United States and the Soviet Union, with this consultation with other states and with a resolution in the Security Council, reach such a first step agreement, you will find that parliaments around the world will rapidly ratify it.

COST OF INSPECTION SYSTEM

Senator SALTONSTALL. Of course, we put up 33 percent of the cost of the United Nations.

Mr. STASSEN. Of the United Nations, right.

Senator SALTONSTALL. We would put up 33 percent of the cost of carrying out these inspections.

Mr. STASSEN. That is right, and it would be a very small cost compared to our arms burden, Senator.

Senator SALTONSTALL. Thank you, Mr. Chairman.

LETTER TO PRESIDENT ON NEGOTIATING WEAPONS TESTS SEPARATELY

Senator HUMPHREY. Mr. Stassen, to come back to a question that I asked you earlier, on the date of November the 4th, 1957, I addressed a letter to the President, a letter which was sent after a visit to the United Nations at which time I recall visiting with you and Ambassador Lodge, Ambassador Wadsworth, and some of the technical personnel that were assigned to our mission at the United Nations during the discussion of the disarmament matter at the U. N. I shall not read all of the letter. It was made a part of the record here on February 4 in the United States Senate.

I read one paragraph:

> I would like to suggest, Mr. President, that the United States, after consulting with its allies, declare its willingness to negotiate separately on a ban on nuclear weapons tests for a 2-year period with the only condition being agreement on an effective inspection system with United Nations supervision to insure that the ban is being scrupulously observed.
>
> It is my belief that such a proposal would be a safe and reasonable one. It would be a concrete step toward ending the arms race. It would also enable the people of this and other countries to learn more clearly whether the Soviet Union is truly ready to accept effective inspection. We cannot challenge the intentions of the Soviet Union on inspection unless we are in a position to negotiate on a test ban, irrespective of the other measures in the four-power disarmament proposal.

Now, it is this same 2-year test ban, under U. N. supervision, which you are outlining here today. But, Mr. Stassen, the reason I read this paragraph from the letter is because, No. 1, I sent this letter to the

President, after consultation with responsible officials, but with no responsibility attached to others. I did receive a reply from the President.

A copy did go to the Secretary of State, Mr. Dulles. A copy did go to Ambassador Lodge and to yourself. The President on November 8 replied, and I read the substantive paragraphs:

> The entire subject of nuclear tests and its relationship to disarmament agreement is under continuing study and review. I am referring copies of your letter to the Secretary of State, the Secretary of Defense, and the Chairman of the Atomic Energy Commission for their consideration in connection with their own recommendations to me. Your own views will be helpful to us.
>
> With best wishes,
>
> Sincerely,
>
> DWIGHT D. EISENHOWER.

Now here was a suggestion from a United States Senator and I did not sign this in my capacity as chairman of this subcommittee because I had no right to do so, since I had no chance to consult with my colleagues. But copies were sent, as the President said, to responsible officers of the Government. A copy was sent to you and to the Secretary of State.

RECOMMENDATIONS TO THE PRESIDENT

Presuming the letter was discussed, since the President indicates to me in his reply that it was being sent around to the Departments for their views and their consideration, my question to you is this: Now that you recommend the 2-year test ban under international inspection, and a very well conceived four-point program, did you make these same recommendations at the time that this letter was under discussion.

Since you received a copy of the letter, since the Secretary of State received a copy of the letter, as well as the Secretary of Defense, and the Chairman of the Atomic Energy Commission, I want to know what did you recommend to the President when you were consulted on this matter?

Mr. STASSEN. Let me first point out that my recommendation in the four parts this morning includes two things that you did not include in your letter. One is the organization of the United Nations regulation and control agency.

Senator HUMPHREY. I have that here, sir.

Mr. STASSEN. I think that is a very important part of it.

Senator HUMPHREY. I surely agree.

Mr. STASSEN. Then you do have the 2-year suspension and you do have the inspection system?

Senator HUMPHREY. Right.

Mr. STASSEN. And I think there should also be a commitment right in the original treaty to set up the negotiating group to follow on through on the succeeding steps that ought to be worked out to carry on from the 2 years.

Senator HUMPHREY. We have that in the Subcommittee on Disarmament, Mr. Stassen. That is its purpose.

Mr. STASSEN. It happens to be a different negotiating approach than that subcommittee. That is another point.

Now to come down to your question, Senator——

Senator HUMPHREY. Just a minute. You have one more suggestion than was outlined here. I am not disagreeing with your suggestions. I commend you for them. My point is——

Mr. STASSEN. Thank you.

Senator HUMPHREY. When you were in the position of the adviser to the President on disarmament, No. 1, did you recommend to the President, to the Secretary of State, to those with whom you were associated at the U. N. separating the cutoff on the nuclear production from the ban on testing.

In the western package, the cutoff of nuclear production and the test ban, were one. They were tied together inseparably. We have all kinds of testimony before this committee from you and from the Secretary of State and others as to that.

Now my question to you is simply this: Did you, during the time that you were an official of this Government, recommend to the President or to Ambassador Lodge or to the Secretary of State or to our allies, the same proposal that you are recommending today?

Mr. STASSEN. It is my view, Senator, that it is not proper for me now or in fact at any time to go into the matter of what my recommendations to the President were at a time when I was his special assistant.

Perhaps historians in the long future go into matters of this kind, but I do not believe when they are contemporary that it is a proper thing to discuss.

Senator HUMPHREY. I appreciate your respect for your official capacity. I hope that we are not to interpret, however, that you did not make these recommendations.

Mr. STASSEN. I think that the important thing is where do we go from here.

Senator HUMPHREY. Yes.

Mr. STASSEN. And it is the future, and I now discuss with you very thoroughly what my views are as to where our country's policies and programs should move from this point forward, but I do not consider it is proper for me to go into what I recommended when I was in an official position as special assistant to the President.

Senator HUMPHREY. Mr. Stassen, this is very important public business as you know more than anyone else.

Mr. STASSEN. That is why I responded to your invitation this morning and that is why I am speaking up, because it does affect not only the security of our country but its prospects for peace in this H-bomb age.

RECEPTION GIVEN STASSEN RECOMMENDATIONS

Senator HUMPHREY. I am trying to find out whether or not you were persuasive in your role. Did you run into resistance on these ideas? Will you continue to run into resistance on these ideas? What is the attitude of the administration?

Now you were in it. You were a fundamental part of it, and I believe that everyone that has been associated with these matters has been associated in spirit with the greatest responsibility, and I do not think it is a matter of trying to be picayunish or just looking for trouble when one asks the question: Did you make these recommendations?

If you did, what was their reception?

Does there seem to be a desire on the part of responsible officials in the Government now to agree with your recommendations, or are you just making recommendations in the hope that somebody might agree?

Mr. STASSEN. It is my view that the recommendations I made to you this morning are sound from the best scientific and military information that can be acquired, that it is a move that will improve the prospects for peace, and it is my hope and my belief that as we focus on this clearly and precisely, world opinion and opinion in parliaments and congresses around the world will lead to this kind of action in the months ahead.

Senator HUMPHREY. Mr. Pastore?

Senator PASTORE. Will the Chairman yield?

Senator HUMPHREY. Just this one final question and then I surely will. I only want to note for the record that on December 15, 1957, the President sent a cablegram to the Prime Minister of India, Mr. Nehru.

In that cablegram the President indicated again:

> I am convinced that a cessation of nuclear-weapons tests, if it is to alleviate rather than merely to conceal the threat of nuclear war, should be undertaken as a part of a meaningful program to reduce that threat.

Then he goes on to point out that this must be tied in with the cutoff of the production of nuclear materials.

That was the official policy of the Government up until at least the 1st of January.

Has that policy been changed prior to your leaving the Government, Mr. Stassen?

Mr. STASSEN. Of course you should not now ask me the policies of the administration, because as of February 15 I terminated my work there.

CESSATION OF PRODUCTION OF FISSIONABLE MATERIAL AS PART OF FIRST-STEP AGREEMENT

On the matter of the cutoff I will give you my views upon it. There is no question that the cessation of production of nuclear material for weapons purposes is a very important thing to attain.

It, however, is not the most important thing to attain, and it is impossible to attain it in a short range because it requires a most comprehensive inspection system that I feel could only be designed and installed in 3 or 4 years of time, because to inspect a cutoff of production of nuclear materials for weapons purposes you would need inspectors in every nuclear installation, including powerplants and production on both sides.

You would need the right to look for other plants that were not reported.

In other words, to inspect the whole of the Soviet Union from end to end, and you would need the right to keep track of the nuclear material that is produced, account for it, follow it and audit it from the time it was produced on through its use in various powerplants or ships and so forth.

Therefore if you make the complete accomplishment of that kind of an inspection system a prerequisite for taking any step, you in

effect make it impossible to make any step in the years immediately ahead, and in the meantime nuclear weapons spread around the world and the danger to mankind goes to very extreme limits.

Senator HUMPHREY. So you openly disagree with the President's position as stated in his cablegram to the Prime Minister of India?

Mr. STASSEN. I today to you recommend a first-step agreement that consists of four parts as I have outlined, and I point out to you that in the President's press conference in June of 1957 he expressed a view that is entirely consistent with and of the same spirit as the recommendation I am making to you this morning.

Senator HUMPHREY. I think that is right and I, as you know, basically support the proposition which you have laid down before us.

ORIGIN OF FOUR-PART FIRST-STEP PROPOSAL

Mr. STASSEN. It is also consistent with your letters, Senator, I agree to that. Let me also give the genesis of the recommendation that I make. It springs out of the negotiations and studies over this period of years.

You will find that the first important recommendation for a short-term suspension of nuclear tests, which is the one of the four parts, came from Prime Minister Nehru of India in 1954. That was the first emphasis on the short suspension of nuclear testing. The emphasis on the inspection being required even for a short-term suspension was the emphasis of the United States that you could not, although we had intelligence devices where you could be quite sure of detecting nuclear tests today, you could not rely upon them unless you got them inside the Soviet Union, and reciprocally you must accept them inside the United States.

So the second part of our four-part first step that I am presenting to you is of United States origin, and that is this emphasis that there must be inspection.

In the London talks on the informal discussion on June 7 for the first time in the long negotiations in 1957 the Soviet Union indicated it was willing to consider inspection posts inside the Soviet Union with scientific instruments. That was a major breakthrough in the negotiations, and as I say, raises this opportunity to make an urgently needed step to gain control.

The matter of a United Nations Commission under the Security Council to administer it is originally a Soviet proposal, particularly in May 1955. The matter of the followthrough on the negotiations was particularly emphasized by Mr. Moch, of France, and to some extent by the United Kingdom and Canada.

So that the four-part first move that I am speaking of has its genesis from India, from the United States, from the Soviet Union, and from our principal allies, and it fits together the practical step that could be taken in the immediate future.

Senator SPARKMAN. Will the Chairman yield?

Senator HUMPHREY. Senator Sparkman?

Senator SPARKMAN. Mr. Stassen, let me ask you this question: Are the views that you have expressed here this morning and the recommendations that you make something new with you, or have you held them for some time?

Mr. STASSEN. I recognize that you are indirectly approaching the Chairman's question.

Senator SPARKMAN. No, I am not asking you anything about what you said to the President.

I just want to find out about your own personal views.

Mr. STASSEN. I think in the present context perhaps I should speak of the future and of today.

Senator SPARKMAN. Have you said anything here this morning that was inconsistent with the views you held at the time you read Senator Humphrey's letter?

Mr. STASSEN. As I say, I feel that I should confine my discussion now from today and what we ought to do in the future, and I sincerely believe that that is the best way to conduct our form of government.

Senator SPARKMAN. May I say that you yourself started telling the genesis of this whole thing?

Mr. STASSEN. That is public, you see.

Senator, I will discuss any matter that is of public information that goes back 1 year or 10 years, and these matters I referred to you about Nehru, and about the United States position and the Soviet Union's position, and France, and so on, those are a matter of public United Nations' records.

That is why I gave you that.

Senator SPARKMAN. Thank you.

INSPECTION WITHIN SOVIET UNION

Senator HUMPHREY. I want to say to you, Mr. Stassen, it has been my belief that the Soviet Union's expression to you and to other members of the Subcommittee on Disarmament at London of interest in and willingness to have inspection within the confines of the Soviet Union was one of the fundamental breakthroughs, as you have indicated.

Mr. STASSEN. Right.

Senator HUMPHREY. And one that I believe we should have pursued relentlessly. That is why I personally have supported the type of a first-step approach that you have outlined here.

I feel so strongly about it that I do believe it is a fair question to ask about the reaction of responsible officialdom to these suggestions, particularly as to the possibility of favorable reaction in the future, because I think we are fast approaching the day when we are going to be sitting down at the disarmament negotiation table again. When that time comes, let us be hopeful that we will be able to approach these negotiations with at least some plausible plans that may lead to success.

EFFECT OF PUBLIC DISCUSSION UPON FOREIGN POLICY

Mr. STASSEN. Let me point out, Senator, that it is almost customary for great moves in foreign policies in a free country such as ours to arise from the discussions of the people and the views expressed by the Senate rather than from other sources.

In other words, the whole development of the United Nations, as you know, came from public discussion and Senatorial resolutions.

The whole development of the North Atlantic Treaty Alliance came in that way.

So I think it is more in accord with what should be expected that these matters of how we should now move should be publicly discussed in this country and in the other countries of the world, and out of those discussions should come the focus of the move to make in the coming months.

DETECTION OF TESTS

Senator HUMPHREY. Mr. Stassen, you have emphasized here the matter of international inspection under an appropriate U. N. commission or agency. You may recall that in the testimony that we have had in the past before this subcommittee, considerable attention has been paid to the inspection part of any disarmament proposal.

Mr. STASSEN. That was one of the cardinal points in our recommendations that were publicly made, that is to the President, and publicly revealed, that any commitment the United States makes should have attached to it the necessary inspection. And these inspection posts that I speak of are an absolute essential of the first step agreement.

And with these scientific instruments, the seismic instruments are very sensitive, so are the acoustic, the electromagnetic and the radiation measuring one, you can have a very effective inspection system.

In fact, it is a matter of public information, and I can say to you, that that very small nuclear shot that was put out underground in last year's test was recorded in every seismic instrument within a thousand miles.

Now when the seismic instruments record that shot, it of course does not say that is a nuclear shot. It shows that something caused a tremor from a certain location.

Then these inspectors must have the right to go to the area indicated on their instruments to see whether or not the seismic or acoustic or electromagnetic indications came from a nuclear test that was not authorized, or whether they were caused by an earthquake or some other kind of natural phenomenon.

That would be a part of the inspection system, and the delicate electromagnetic and acoustic instruments pick this up at great range, and with the radar approach, if the shots are sent up into the upper atmosphere, why you find the missile going up.

NUMBER OF INSPECTION STATIONS

So I think 11 or 12 inspection stations properly placed throughout the Soviet Union territory and the United States and our Alaskan and Pacific islands will make it as certain as anything on earth can be certain that unauthorized and illegal tests could not be conducted without being observed.

Now you cannot of course say with an absolute scientific certainty, because nothing on this earth can be absolutely scientifically certain, but it can be as certain as any matter with which human beings are concerned.

Senator HUMPHREY. Senator Saltonstall.

Senator SALTONSTALL. Will the Senator yield for one question?

Senator HUMPHREY. Yes.

Senator SALTONSTALL. The Soviets never showed any inclination to agree to let any inspectors from those stations to travel in areas of Soviet territory, did they?

Mr. STASSEN. Yes; they did.

Senator SALTONSTALL. I thought they limited it to a 500-mile radius from the borders.

Mr. STASSEN. No; that is the other type of inspection, Senator. That was in the open sky zones that were under negotiation. That is a matter of other steps to take up. But they did not put any geographic limitation when they responded to our requirement of inspection posts and scientific instruments in the London negotiations in regard to the suspension of testing.

Now of course when you come down to specifically outlining those 11 or 12 posts and what instruments they would have and what personnel they would have, it is possible that you would find an intransigent point of something essential on the part of the Soviet Union, and that you could not go forward.

But the indications are that this is the most favorable, sound, and mutual move that could be made in the armaments control field.

TEST SUSPENSION SUPERVISORY PERSONNEL

Senator HUMPHREY. You are familiar, Mr. Stassen, with the attitude expressed before this subcommittee and in public statements by Admiral Strauss wherein he has indicated that we did not have enough trained inspectors to supervise this type of agreement.

In fact, Admiral Strauss has said before this committee that we did not have enough supervisors to inspect either the cutoff of nuclear materials production or the cessation on tests.

I want to come back to what Mr. Moch of France had to say in reference to the cutoff of nuclear materials.

Mr. STASSEN. Just let me interject that there would not be a personnel problem.

In other words, these 12 inspection stations with international personnel, there are ample competent men in the world to man these 12 stations on both sides.

TASK FORCES

Senator HUMPHREY. You recall that one of the task forces you were to appoint was one that related to the development of plans and proposals for inspection.

Am I correctly informed on that?

Mr. STASSEN. We had nine task groups.

Senator HUMPHREY. Yes; I said one of the task forces was in the inspection field; is that right?

Mr. STASSEN. All eight had to do with different types of inspection.

Senator HUMPHREY. We have tried to receive some information concerning the work of those task forces, Mr. Stassen. Has the work of those task forces been completed?

Mr. STASSEN. I think any question now of the activity within the administration should not be put to me.

Senator HUMPHREY. Were they completed up to last month?

Mr. STASSEN. Those task forces served very ably during the time that I had the responsibility.

Senator HUMPHREY. What is so secret about what a task force is doing in the field of inspection, for example?

I frankly cannot understand this. The American people are vitally concerned, that if we enter into any type of disarmament agreement, that it is one that has reasonable assurances and guaranties of success, and of nonviolation.

In other words, that it will be reasonably secure and trustworthy. Therefore, it appears to me that discussion of these matters is of the utmost public importance and should be as much as possible public.

Now I can understand where the AEC may have some very delicate instrument or some delicate scientific device that it may not for the moment want to divulge or expose to public view, but I must say that if we can have discussions before committees of Congress as to the latest missiles and rockets and discussions as to antimissiles and submarine missiles and all of the most fantastic technical developments, why can't we have discussion as to what is being recommended by a task force insofar as inspection devices and inspection programs are concerned.

Mr. STASSEN. There is no reason why you could not have testimony on any of these inspection and scientific matters, but it is a different question as to whether a specific report to the President within the executive branch of the Government would be made public.

That involves different questions, and sometimes, as you say, very sensitive information, and the whole procedure of a President having advisory groups that are within the executive branch only.

ATOMIC ENERGY COMMISSION

Senator HUMPHREY. Could you give me any expression as to whether or not the Atomic Energy Commission, in particular the Chairman of the Atomic Energy Commission, sees eye to eye with you on the matter of the first step disarmament proposal?

Mr. STASSEN. I do not feel that I should be the source of the views of other men.

Senator HUMPHREY. What was your view of his view?

Mr. STASSEN. Except to the extent that they have publicly expressed their view.

Senator HUMPHREY. What is your view of the view of the AEC personnel relating to your proposal.

Mr. STASSEN. It is my hope that, as this issue is focused on around the world, the Atomic Energy Commission would find that it was a wise first step to take.

Senator HUMPHREY. Do you feel that there is much chance for the fulfillment or the realization of your hope, Governor? You see, I have the same hope and I am just trying to find out. You worked more closely with these people than members of the subcommittee, and I think we have a right to know.

Is there a favorable reception, is there a friendly reception to the views that you express? Your views are not merely personal, Governor; they are views as a result of 3 years of meticulous and concentrated dedicated experience, and I want to know whether or not these views are receiving any favorable reception.

I know they got some favorable reception in Canada, and I understand that they had favorable reception in Norway. I understand they also have had favorable reception in Italy. But what I am

really more concerned about is this: Is there any kind of favorable reception in Washington?

Mr. STASSEN. I think your side of the table would be the beginning point in that regard, Senator. As I pointed out a minute ago, the great foreign-policy moves in this country spring from thorough public discussion and Senatorial action.

Senator HUMPHREY. That is what we are trying to do here.

Mr. STASSEN. It is rather natural under our form of government.

Senator SALTONSTALL. Would the Senator yield for a question?

Senator HUMPHREY. Yes, indeed.

Senator SALTONSTALL. Right along the same line, Governor Stassen, of course, we all agree that we can disagree as to recommendations made at any time, but I would like to ask, in making any recommendation to the President or to the Secretary of State, but particularly to the President, did you not always find him anxious to do all that he could to get a more peaceful world and to do all that he could in a practical way to have the United States cooperate in that endeavor?

Mr. STASSEN. I pointed out, Senator, that, in his press conference last June, he expressed views publicly that are very much along the lines of the first step that I urged this morning.

Senator SALTONSTALL. In other words, I think you can answer this question properly, in any conversations you always found an attitude in President Eisenhower, an attitude anxious to do what he could to get a more peaceful world.

Mr. STASSEN. There is no question of the President's deep devotion to the objective of peace. At the same time, you must recognize the difficulty of a President moving on matters if there are different views on the part of some of his principal advisers, if there is uncertainty as to the attitude of other NATO countries, and if there is uncertainty as to the attitude of the United States, that must ratify any treaty that is involved.

POSSIBILITY OF REACHING AGREEMENT ON FOUR-POINT PROPOSAL

Senator HUMPHREY. Senator Pastore?

Senator PASTORE. Governor Stassen, I feel that no living American knows more than you of the frustrations involved in the area of disarmament and particularly in negotiations of this type. You have had a most intimate association with these negotiations in London and New York and wherever disarmament has been discussed. You have dealt with representatives from many nations. You have met seriously and studiously with many men. I believe that you know how they think. I am sure you have learned how they talk and act.

Now, this morning you have come before this committee, and while you do not want to predate at all previous to your speaking to us this morning for fear that it might touch upon what your attitudes and recommendations might have been when you were a special assistant to the President of the United States, taking into account our package as we suggested it at London during the time that you were the chief representative of this Nation, and taking it now at this moment when you are making this 4-point program, realizing the fact that we failed on our package suggestions at the London Conference, and we failed to achieve an agreement when we discussed disarmament in New York

several years ago, what is your feeling now as to the possibility of achieving agreement, realizing the attitudes and realizing that your knowledge of the past is a background in dealing with these people, what is your opinion now as to the possible success of this 4-point program that you are suggesting here today?

Mr. STASSEN. First of all, may I humbly thank you for your gracious comment. It is my view that this first step could be negotiated within the next 6 months successfully with all the states concerned. I believe that it would best be consummated at a summit meeting between the heads of government.

I feel such a summit meeting, if you began to prepare for it along these lines now, could be held within 4 or 5 months; that it, I think, could best be held at the United Nations with the Secretary General as sort of a moderator and manager of it, so that all other nations felt that this was within the United Nations context, was not something that was pulling away from the United Nations; and I believe that a treaty along these lines could actually come before the United States Senate before this session ends, because all of the technical, the legal, the scientific work is in an advanced stage.

EFFECT OF A BAN ON PRODUCTION UPON FOUR-PART PROPOSAL

Senator PASTORE. I ask you this further question, and I hope you believe me when I say I am not trying to get into this area that you refused to get into at the time the chairman was asking you these questions: What would you think of the possibility of achieving success with this 4-point program if we tied onto the 1 part that calls for a cessation of testing for a period of 2 years this other agreement of ceasing the production of all fissionable material? Would it doom it; would it dim its prospects of success?

What would it do to the possibilities of success if we tied into 1 of these 4 parts this additional part of getting agreement to cease the production of fissionable material? I do not want to get into the area of recommendation. I am speaking about the future now.

Mr. STASSEN. It would be my view that tying it into those other parts would make agreement impossible within any conceivable range of years because it would require an inspection system so thorough and extensive that it would take years to establish it, that it might then not have the degree of efficiency that would be necessary to make the commitments, and that in the meantime nuclear weapons would spread around the world.

The whole control problem would become more difficult, and this moment in history when you might get control and mutual opening up would be gone.

Senator HUMPHREY. Mr. Stassen, I have 1 or 2 more questions I want to ask you.

I should just like to note for this testimony that on March 7, 1956, when we had before this committee in public hearing Admiral Strauss, of the Atomic Energy Commission, testimony on pages 125 and 126 of the printed hearings indicates quite unequivocally as follows relating to the breakup of the disarmament package and negotiating on a piecemeal basis or less than the total package.

Admiral Strauss says:

I think it is beyond my competence to comment on force levels, conventional weapons, and that those things are subjects for the kind of negotiation which presumably will be carried on by Mr. Stassen and the team that he will take to Europe within the next few days.

I expressed my own view a few months ago to the effect that I thought that any plan that might be advanced ought to be comprehensive and not attempt to be a piecemeal plan. But that also is purely a personal attitude, and I do not know that it has any part in our strategy.

Subsequently, we discussed this matter again and Mr. Strauss expressed in response to a question from the chairman his opposition to any further proposals on banning tests, "unless it is part of an overall plan," and I quote him again from the record.

That is the only reason I ask the question, Mr. Stassen, because Mr. Strauss is a very important figure in Government. I know we are not going to get anywhere here this morning arguing about whether or not he has changed his view or whether you were able to change his view. But this is a matter of public record.

AGREEMENT ON CESSATION OF TESTS BETWEEN THE U. S. S. R. AND THE UNITED STATES

Now my next question relates to your proposal that the agreement could be between the United States of America and the U. S. S. R. on banning of tests for 2 years under the type of inspection which you have outlined.

Mr. STASSEN. Senator, it would be a multilateral agreement.

Senator HUMPHREY. Yes.

Mr. STASSEN. The whole United Nations, but the first abstention——

Senator HUMPHREY. Would be from those two.

Mr. STASSEN. Would be from the two who are way out ahead.

Senator HUMPHREY. Yes.

Mr. STASSEN. And where the problem centers. In other words, you do not have a first step that is meaningful unless it affects both the Soviet Union and the United States, and unless it includes inspection.

Senator HUMPHREY. Exactly, I understand that.

Mr. STASSEN. If you can begin with those two, you have made a significant beginning, and then the odds are favorable to moving on to successive things. That is the essence of my position.

Senator HUMPHREY. And you believe that this is to the mutual interest of both nations and of course to the world; is that correct?

Mr. STASSEN. And to mankind, that is right.

Senator HUMPHREY. That is correct.

Mr. STASSEN. That is in the absence of any agreement. You gentlemen know from your briefings and your consideration of these modern arms, you can envision what the future world will be if we continue to fail to get any kind of inspection or any kind of agreement, and there is an awareness on the part of the Soviet Union as well as the United States that a modern war with these weapons would not only have such tremendous devastation on both sides as to be a vast net loss, but it would also have a profound effect on the human race because you would have such radiation that it would affect the genetic processes and you are dealing with one of the most important questions of history.

NEED FOR INITIATIVE

Senator HUMPHREY. In light of your observations, Mr. Stassen, I am sure others around this table have had similar observations—but, I can only speak for myself—isn't it then the responsibility of the United States of America to pursue this type of a negotiation?

Mr. STASSEN. I feel we should take an initiative.

Senator HUMPHREY. Yes.

Mr. STASSEN. In this direction; yes.

Senator HUMPHREY. Do you think the world of public opinion feels that we have hesitated on this type of initiative, or do you think world public opinion lays at our doorstep the blame for failure to make more progress.

Mr. STASSEN. I would simply say that the most important thing is what happens from this day forward.

I think we can leave to historians to do the rest. You certainly must lay a very heavy measure of blame on the present situation in the world upon the Soviet Union.

Senator HUMPHREY. Of course.

Mr. STASSEN. But if we want to spend all our time on what blame should be assessed for the past, we fail to meet the problems of tomorrow.

Senator HUMPHREY. Do you think that world public opinion will vigorously support our initiative in this matter?

Mr. STASSEN. I believe an initiative in this direction will be acclaimed around the world.

NUCLEAR-WEAPON TESTS BY OTHER COUNTRIES

Senator HUMPHREY. I agree. Now Mr. Stassen, you said that one of the first steps would be in this multilateral agreement, the U. S. S. R. and the United States of America, for at least these 2 great powers to stop the tests for 2 years. I am sure a question immediately comes to the minds of many people——

Mr. STASSEN. With inspection, remember, Senator, always say with inspection.

Senator HUMPHREY. That is a matter of the record, with inspection. I imagine some people will ask under those arrangements would it not be possible for one of our friendly allies to conduct for us a test of our weapon, even though they did it in their name; and we might well ask would it not be possible for one of the satellite states to conduct tests for the U. S. S. R., conducting them in their name but using a Soviet weapon.

Now how do we get around that?

Mr. STASSEN. It would not be possible for them to do it without it being detected. By that I mean if there is a devious avoidance of the 2-year commitment on either side, it would be known promptly by the other side and by the world with this inspection system, and with our continuation of our regular intelligence methods, and consequently you would then know, that is if we cheated in this manner, they would know that there is no use trying to go on beyond the 2 years into further steps. If they cheat in the first 2 years, we will know it is no use trying to go further in further steps with them, and that is a very important thing to find out on each side.

Therefore, it is my view that since there is such a mutual interest in avoiding the kind of a future that otherwise will face both sides, that the agreement would be respected. But this is an important reason for me saying a 2-year trial, because this means that there would be no commitment beyond the 2 years unless there is a new treaty and the United States Senate looks at it again. So you are making only this limited but very important commitment that starts opening up to inspection on both sides, and that both sides abstain, agree to abstain from nuclear testing in this 2-year period.

It is a very important step. It is a first step, but it has its limits and it has its built-in safeguards, because you could move right back to testing at the end of 2 years, and in the meantime keep a very powerful military position and keep alert, because this is not a substitute for our armed position. This is an endeavor to open up a trend that will have some more favorable prospect of avoiding the kind of tragic war that would come if ever through miscalculations or incidents or explosions we draw these two great powers into the kind of destruction of which they are both today capable.

RELATION OF COMMUNIST CHINA TO TEST SUSPENSION

Senator SALTONSTALL. Mr. Stassen, if Communist China, which is not a part of the United Nations, conducted a test, would you consider that a satellite of Russia? Would it come within the purview of what you say about this agreement and the conduct of it?

Mr. STASSEN. It would be virtually impossible for Communist China to carry out a significant nuclear test during the 2 years without it being known, and it being known within a reasonable period of time, we could be quite certain whether the Russians had a part in it.

In fact, with our knowledge of the state of nuclear science in China, it would be a virtual certainty that if they conducted a test within the 2 years, it would be in fact a Russian test illegally conducted.

Senator HUMPHREY. I would only add that one of the most eminent nuclear scientists told me not long ago, a gentleman that had a distinct part in the development of the first A-bomb, Dr. Niels Bohr, that we had little or no information as to the state of nuclear science in China, that he thought this was one of the great weaknesses in present negotiations. That is why I have said many times I doubt that we could really go too far in disarmament discussions, although I must say I am not including the first step. I think you can go on with the first step, but ultimately, this whole problem of China, this great land mass with approximately 700 million people must be brought within the scope of some kind of agreement if you are going to have any kind of disarmament agreement that is going to protect the security of the United States.

I cannot imagine anybody wanting our great Nation to be disarmed and have Red China an armed mass, because they have been able to develop at least military capability.

Mr. STASSEN. Remember, Senator, that this first step does not disarm the United States.

Senator HUMPHREY. I understand that.

Mr. STASSEN. It does not take away a single bomb, a single plane, a single missile or a single gun, and we must remain very powerful. But it begins to open up on both sides and set up the United Nations

machinery that has some prospect then of step by step going forward and decreasing the danger of war.

Now there is no question that ultimately you do need to encompass all areas of the world, but the great danger of catastrophe centers in the tremendous nuclear capability of the Soviet Union and the United States, and that is where you must make the beginning.

EFFECT OF PROVISION TO ALLOW FOR TESTS BY OTHER COUNTRIES

Senator HUMPHREY. The point that I was trying to get at a little while ago as to other nations testing weapons, and to which you have given very fine comment, is one that was emphasized before our subcommittee by you and others, the so-called fourth and fifth powers. This was part of the concern in the London conference as I recall, and I do feel that while of course it would be a first step, and an advantageous first step in my mind to get the kind of agreement that has been discussed here this morning, we must not ignore the fact that testing on the part of other nations can place them in the nuclear weapon field. I have the feeling that one of the reasons we provide that in the beginning just the U. S. S. R. and the United States should cease testing is because of the discusions that have been held relating to such countries as France that would like to have a nuclear weapon, and we are bending over backwards in an effort to take care of an ally and possibly doing so at the risk of seeing a Poland, an Egypt or a Czechoslovakia or somebody else coming into the field.

Mr. STASSEN. My only comment on that, Senator, is that in this matter of such great moment, just as in ordinary matters, if you try to make too big a step at first, you take no step, and that the key place to make the first step, as I said before, is between the Soviet Union and the United States with all other nations joining in the United Nations machinery, and I believe that all these other related questions of the position of France and Poland and so forth are much more likely to fall into logical place and fit into a movement toward a more secure peace if you do it that way, than if you try to load the first step with a lot of other commitments involving a lot of other governments.

Senator HUMPHREY. I merely brought up the question because I am sure that the questions do not necessarily indicate my personal attitude. It is because they are questions which have been presented before, and I only hope, and again I say, that the views which you are expressing here today will be somewhat contagious and the process at least of intensive multiplication of their effect will take place.

RESPECTIVE FOREIGN POLICY ROLES OF THE LEGISLATIVE AND EXECUTIVE BRANCHES

Mr. STASSEN. The most important place for these thoughts to be considered is in the United States Senate.

Senator HUMPHREY. I appreciate your spirit of respect for the Senate, but I still think that the White House and the State Department has got a little edge on us when it comes to foreign policy with responsibilities in administration.

Mr. STASSEN. I recognize a great responsibility on the part of the President and the Secretary, and of course all these other govern-

ments and other parliaments, but the basic reason that I responded to your invitation in your telegram of February 24, Senator, is my own observation through the years that the most significant moves in foreign policy center in the initiative of the United States Senate.

Senator SALTONSTALL. Mr. Chairman.

Senator HUMPHREY. Senator Saltonstall.

Senator SALTONSTALL. The initiative has got to be in the administration, and I am confident you will agree with me that the present administration is going to do its utmost in every honorable way to look after the security of the United States. That is primary; that is the first responsibility, and to do that it has got to also work to try and get a more peaceful world and to include disarmament.

But the initiative for developing foreign policy I am sure you will agree with me is in the executive department of our Government.

Mr. STASSEN. The broadest initiative on the most far-reaching policies has in our history centered in the United States Senate.

I agree there is a very major responsibility for initiative in the President and the executive branch.

Senator HUMPHREY. Just at this point in the record I should like to read from page 11 of the report of the Subcommittee on Disarmament, Report No. 1167, page 11:

> If the major powers are to succeed in the enormous task of reducing their armaments, it is the judgment of the subcommittee that success can come gradually, a step at a time. A limited disarmament agreement has the advantage of testing the good faith of the parties without, so to speak, putting all our security eggs in one basket.
>
> It may act as a partial brake in the armaments race and as a result reduce international tension sufficiently to allow the major powers to negotiate on some political questions.

Then, later on, in light of your testimony, Mr. Stassen, page 13, it says:

> The subcommittee has concluded that a disarmament agreement must include measures to test the observance of its provisions. Measures for inspection, adequate to safeguard each separate disarmament proposal in the package may, however, when added together, be so extensive as to be impracticable or unacceptable.

That is, when you add up everything all at once and try to provide instantaneously the inspection facilities, you may have undertaken a bigger responsibility and job than we were momentarily capable of fulfilling.

Any other questions?

RUSSIA'S RECENT TEST

Senator PASTORE. Only one thing. I think it is associated with it. Yesterday, as you know, the Russians tested two more nuclear weapons. They could have been thermonuclear. I am very much surprised to see that, in one of the best newspapers in the country, the Washington Post, there is a report on the front page that is about 2 inches in breadth, about an inch and a half in height, and in the New York Times it is on the third page, one-half a column. The thing that is disturbing to me is this. Realizing that the sword of Damocles that hovers over the head of mankind today is a destructive power of nuclear and thermonuclear weapons, I'm a little afraid that all of this

business is becoming so commonplace that it is beginning to lose the prominence in its news value that I think it deserves.

I am not being critical, but I think it would be a horrible day for us and the entire world if we begin to accept these very destructive things as commonplace, and not be alerted to the very devastating and chaotic destructive force of nuclear and thermonuclear weapons. We are dealing today with bombs that can destroy entire States.

The tragedy of the world and the paradox of our time is that these bombs are not alone in our possession but they are in the possession and in the arsenals of people who do not believe in the same ideology as we do, and that is the contest of our day. And, realizing this contest and realizing the importance and what it means not only to our generation but other generations to come, I would not want to see any situation or any development where we begin to accept these revelations as commonplace and lose interest in what we have to do as a people and as a nation to bring about an agreement whereby these weapons won't be visited upon people in any part of the world.

Mr. STASSEN. That is an excellent statement, Senator. I hope we might both do something to arouse and focus interest upon this most important problem.

EFFECT OF TEST SUSPENSION UPON OUR DEFENSE POSTURE

Senator HUMPHREY. Mr. Stassen, one other question. Would our weapons program or our total military posture suffer from a 2-year test suspension?

Mr. STASSEN. It would unquestionably be some handicap upon the proving out of future experimentation.

There would also be the same handicap upon the Soviet Union of Russia. In other words, this would be an even effect on both sides under this inspection, and we do now have proven out a very extensive family of weapons and have them in large supply, so that we would be in a very powerful position during the 2 years on the basis of the research and tests that have already been conducted, and both sides would start to abstain in the further testing that would go on, but the research on both sides would not be stopped. That is why it is a limited trial, but a very important trial to make as a first step.

Sentaor HUMPHREY. Relatively, then, our position would not be any worse than it is now, or any better.

Mr. STASSEN. Relatively, our position would be better, because relatively——

Senator HUMPHREY. You mean with suspension of tests?

Mr. STASSEN. The prospects for peace for the benefit of both improve the moment you start putting inspection in on both sides, and the moment you get the United Nations control going. Not by any means, then, meaning that it is a great improvement or that you can just sit back and relax. That is why I put the fourth part in, that then you must proceed with these persistent negotiations to work out the further steps. I have views upon where we might well go then, but I do not think this morning is the time to go into them. I also, of course, have considered every conceivable objection that some raise to this kind of a first step that I recommend. I do not think it is pertinent to try to anticipate all those objections. The most impor-

tant point right now is: Would the NATO countries approve and go along with this agreement?

Senator HUMPHREY. And you think they would?

Mr. STASSEN. I feel certain they would, but this answer has to come from them, and then we move on. There was this other point of could you have effective inspection, and, as I indicated, if you put the shot down under, it has been proven that seismic recordings can be picked up, even on the smallest shot, and that test shot is known to have been much smaller than even the earliest bombs we had, and if they try to put it up out of the atmosphere, then the process by which the rocket goes up itself can be recorded by radar, and then the airplane can fly up to see or test rockets can be sent to see whether there was a nuclear explosion on the end of that rocket. So that, if you put the competent scientists to work, and they are international, they are not limited to the Soviet Union and the United States, an inspection system can be put in that is as certain as anything human can be.

Senator SALTONSTALL. And I assume from your answer that you do not include in that the testing of ICBM's—ICBM's and all the satellites and that sort of instrument?

Mr. STASSEN. No; that is another field; that is right; of course, the radar would tell whether such things were going up and then you would check whether they had nuclear explosions at the end of them as a part of this enforcement. This is a limited first step to begin to open up, begin to establish the machinery, and to pursue the negotiations. Of course, as a product, you stop the nuclear explosion itself, and you mentioned that Russia is conducting some now; we are planning some.

Unless you make steps of this kind, you must anticipate a constant expansion in nuclear explosions as more and more nations come in and as more and more ideas come up in Russia and the United States of different types and designs they would like to have, and you go on in that direction with all of its evils for the future.

TESTS TO REDUCE FALLOUT

Senator HUMPHREY. Another argument, Mr. Stassen, that has been presented against suspending weapons tests relates to the need for testing in order to reduce the amount of radioactive fallout resulting from explosions. This has been advanced again and again by some of the scientists, and particularly by some of those associated with the Atomic Energy Commission. Now, regarding this argument, is it a valid one, and, if so, how do you weight it against the arguments to end the tests?

Mr. STASSEN. It is not a valid argument. There is no scientist that claims that they are going to have a completely clean weapon within 2 years. They speak of it as something where research and process in 5 or 6 years might prove it out, so it does not affect the first 2 years, and I do not believe that any scientist would come before you and claim that he is going to be ready to test a completely clean weapon in 2 years.

If he does, there is something major happened in a breakthrough within the last couple of weeks.

PEACEFUL USES OF NUCLEAR WEAPONS

But going on beyond, in the longer range term, if the scientists in any country develop a completely clean nuclear explosion, that has peaceful potential to move great mountains of earth, to open up harbors, to dig canals and the international tests of such a clean explosion could be included in any future treaty under international participation, because then you would want that knowledge of a clean explosion to be known by all countries, and you would want to turn it to peaceful uses.

So that argument is not one that will stand the test of thorough consideration in this 2-year trial of an ending of all nuclear explosions.

Senator HUMPHREY. In other words, it would be possible to direct international energies through appropriate international instrumentality or agency into the field of research to produce this type of clean explosion which could be directed for peaceful purposes.

Mr. STASSEN. That is right. As a matter of fact that could be conducted under an international atomic energy agency itself with scientists participating, and it is not within the 2 years.

I do not know of any scientists who claims you could do it in 2 years. If somebody claims he is going to be ready in 2 years, I think that should be very carefully analyzed.

Senator HUMPHREY. I am not sure that the claim has been made that it could be accomplished in 2 years.

Mr. STASSEN. I do not know of anybody that has claimed it.

Senator HUMPHREY. I do think the claim has been made, however, that a cessation of tests would impair the advancement in this field. I do not necessarily subscribe to that but that claim has been made.

Mr. STASSEN. I do not think any scientist has claimed that a 2-year suspension would impair that research.

Senator HUMPHREY. If not impair, would impede?

Mr. STASSEN. It would not impede it.

Senator HUMPHREY. I hope you are right.

TESTS TO DEVELOP SMALL NUCLEAR WEAPONS FOR TACTICAL PURPOSES

A third argument against the suspension of nuclear explosions is that tests of small nuclear weapons are essential in order to perfect weapons for tactical use in the eventuality of local conflicts. In other words, to broaden the arsenal and to diversify the arsenal of our atomic weapons.

What is your response to this argument?

Mr. STASSEN. We already have tactical weapons that are very efficient. It of course is true that continued testing will refine and spread the weapons on both sides, but that specifically is a thing that should be reciprocally stopped in the interest of the best prospects for peace and opening up on both sides, so it is a matter of a restraint for 2 years on both sides enforced on both sides.

Senator HUMPHREY. Any other questions, gentlemen?

Mr. STASSEN. Thank you for your courtesy, Senator.

CONCLUDING REMARKS OF THE CHAIRMAN

Senator HUMPHREY. Governor, may I assure you that we will pursue this question patiently and responsibly.

There are those of us who feel that decided progress can be made.

I want to commend you on your statement, and to join with you in urging that the initiative in this quest for peace and this first step that may lead to further steps be undertaken by our country. If the United States can help in this, and I believe it can, then indeed it is our responsibility to do as we have done here this morning, engender a spirit of understanding and support amongst the public.

Thank you very much.

Mr. STASSEN. Thank you, Mr. Chairman, and Senators.

Senator HUMPHREY. The committee will now be in adjournment.

(Whereupon, at 11:50 a. m., the committee was adjourned.)

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CONTROL AND REDUCTION OF ARMAMENTS

UNIV. OF MICH.

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HEARING

BEFORE A

SUBCOMMITTEE OF THE COMMITTEE ON FOREIGN RELATIONS UNITED STATES SENATE

EIGHTY-FIFTH CONGRESS

SECOND SESSION

(Pursuant to S. Res. 93, S. Res. 185, and S. Res. 286, 84th Cong., S. Res. 61, and S. Res. 241, 85th Cong.)

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NOTE.—Sections of this hearing have been deleted in the interest of national security. Deleted material is indicated by the notation "[deleted]."

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CONTROL AND REDUCTION OF ARMAMENTS

THURSDAY, MARCH 6, 1958

UNITED STATES SENATE,
SUBCOMMITTEE ON DISARMAMENT
OF THE COMMITTEE ON FOREIGN RELATIONS,
Washington, D. C.

The subcommittee met, pursuant to call, at 4:10 p. m., in the Foreign Relations Committee room, United States Capitol Building, Senator John O. Pastore presiding.

Present: Senators Pastore, Symington, Wiley, and Bricker.

OPENING REMARKS OF THE CHAIRMAN

Senator PASTORE. I am going to read a statement prepared by Senator Humphrey. [Reading:]

Of all the problems of disarmament, none is more complex than the control of nuclear weapons. Even with the development of revolutionary systems of delivery such as an intercontinental ballistic missile, it is the nuclear warhead which makes the potential destructive capacity so great. Discussion and study of the control of nuclear weapons has been going on for 12 years and it must continue until we substantially decrease, if not eliminate, the possibility that they will be used in war.

Today the hearing of the Disarmament Subcommittee is devoted to obtaining information on problems involved in controlling nuclear weapons. In this hearing and others in the future, we expect to get the views of competent authorities including nuclear scientists. It is my hope that these hearings will contribute to progress toward securing a safeguarded agreement on the control of nuclear weapons.

In discussing the control of nuclear weapons this subcommittee is not planning to study in detail the question of radioactive fallout since this matter is being studied in the Joint Committee on Atomic Energy.

INTRODUCTION OF DR. LIBBY

Our witness today is Dr. Willard F. Libby, who has been a member of the Atomic Energy Commission, and I might say parenthetically one of the best, since 1954.

Prior to that time Dr. Libby was a professor of nuclear studies at the University of Chicago. I have written to Dr. Libby that although this hearing is being held in executive session to enable him to give us all the information he can, the subcommittee would like to release as much of his testimony as is consistent with our national security.

Now, Dr. Libby, you may proceed.

STATEMENT OF W. F. LIBBY, MEMBER, ATOMIC ENERGY COMMISSION

Mr. LIBBY. Senator Pastore, I have a few remarks that I would like to make in the beginning.

I am pleased to, of course, have the opportunity to testify before your Disarmament Subcommittee of the Senate Committee on Foreign Relations.

The awful moment of the disarmament negotiations and the continuous seeking for some type of agreement to allay a heavy burden of armament and armed forces and the growing ineffectiveness of warfare as a method of settling international disputes lead us all to agree that we must seek for agreement as long as any hope remains, that is as long as we are not engaged in actual all-out war, or as a matter of fact, as long as life itself remains.

The Atomic Energy Commission has, as you know, Senator, the charge of developing the atom in both its warlike and peaceful aspects, and we are keenly aware of the great potential for both good and evil that the atom holds. Nuclear war is so terrible as to be almost beyond comprehension, and on the other hand, the good things the atom can bring us are almost beyond measure in the variety and magnitude of their benefits.

Therefore, we very much would like to have an effective arrangement for disarmament which would allow us to develop the peaceful use of the atom as quickly and as completely as possible. We would like to bring forth the full potentialities in atomic power and in isotopes and in the nonmilitary applications of nuclear explosions.

I want to emphasize this last point. It is an old story that everything technical has beneficent aspects as well as bad aspects, and nuclear explosions are no exception.

UNDERGROUND TEST

Last fall on the 19th of September we fired a bomb underground in Nevada. This was a small bomb. We made it small for the reason that we were afraid of earthquake shocks, though all the theorists told us that the shocks from the earthquakes would be minimal, as they were.

Nevertheless, we wanted to be safe, so we picked the softest, spongiest mountain we could find, and it consisted of tufa volcanic ash which was partially congealed and was quite porous and therefore like a sponge, more or less. We put the bomb 800 feet down in this mountain and its yield was about as small as has been fired, that is 1.7 kilotons.

Well, we fired it on September 19th. The only thing that we saw, the mountain jumped about 6 inches, we saw that, but our Geiger counters showed no effects and we were quite worried that there might be some fissures develop so that the radioactivity might get out.

Among the radioactive products of a bomb are some gases, krypton, for example, and zenon, which have no chemical formula.

These things are permanent gases but we could not even find those. After waiting for a few days we started drilling to find this bomb, and we kept drilling.

We drilled straight down. We had in mind the notion that the bomb would have melted a glob of rock and the energy, of course, is quite sizable, and we were afraid that when we got in and hit this, that something horrible like an explosion would occur, and so our drill crews were very cautious about it, but they kept drilling away, and when they got about half way down into the mountain, about 400 feet down, they found a cavity, that is the drill machinery dropped about 50 feet, and in this cavity they found a little tiny whiff of radioactivity, the first sign. Then they kept going and they found that from here on in it was impossible to keep the drilling water going, that is the drilling water seemed to just flow away to infinity. There was a porosity in the rock which was not there in the mountain before.

Well, we kept going until we got right down to ground zero where the bomb was, and we still had not found anymore except this little whiff of radioactivity that we found about half or two-thirds of the way down. So the problem at that point, this was about 2 months after the bomb was fired, was what in goodness happened? Where was this bomb? We knew perfectly well that it had gone off and we knew the radioactivity was trapped in there, so we could not find it.

We had put the bomb in the mountain by taking a tunnel 2,000 feet long into the side of it.

It isn't a mountain. It is a mesa, and so we went in the tunnel, and of course we looked in the tunnel before, but the tunnel was closed out to about 200 feet from the bomb site, and we had rather expected that the tunnel might be closed farther out by the explosion.

The tunnel was straight for about 1,600 feet and then made sort of a spiral and we put the bomb in the center of this spiral.

Well, when we couldn't find the bomb by drilling downward, then we went in the end of the tunnel and started drilling horizontally, pointed right at the bomb, where the bomb had been. Well, we got in and about 50 feet from where the bomb was known to have been located, we found a little bit of radioactivity again, quite a little bit this time, but it was only in a layer about so thick [indicating].

Then we kept drilling, and again we got right to ground zero, and no bomb.

Then we sat down and did the thinking that we should have done 2 months before, and figured out where it was. To make a long story short, what had happened was that the bomb had blown itself a bubble of gasified vaporized rock, and this bubble was about 110 feet in diameter and about 55 feet in radius, and the skin of this bubble was molten rock about 4 or 5 inches thick, and in this molten rock was all of the radioactivity of that bomb, even the gaseous products were trapped in this molten rock. Then it cooled. Now the shock wave had gone beyond where the bubble expanded and had broken out to 130 feet, had pulverized the mountain, so what happened was that the rock that overlay this thing had no more strength, and when the bubble cooled, when the heat cooled to the point where the pressure of the

gas inside the bubble would no longer support the weight, which of course was just a few seconds afterwards, the thing collapsed of its own weight. So what we were looking for in there was a broken egg, really, an egg shell which had been crushed, and so our bomb fragments were entirely in the form of sort of a bowl underlying the ground zero point.

Then we drilled from the end of the tunnel, we went down at a slant and sure enough, we found the hot rock. Now the rock was black, dark colored. You could pick it out visually. That is, the radioactive material is entirely in rock which you can visually distinguish from the rest of the mountain. You can, of course, do it with radio instruments very easily, because it is intensely radioactive, but there are a number of things you can learn from that.

LESSONS OF UNDERGROUND TEST

First, you can fire bombs in a way where the radioactivity does not come out. Second, you can crush an enormous quantity of rock. This little, tiny bomb, 1.7 kilotons—I don't know that you should ever call any bomb tiny, but I mean on a relative scale this little fellow—broke 400,000 tons of rock, crushed it up.

We found about two-thirds of the energy released in the bomb clustered around the site. What had happened was that the rock was porous and there was water in it, and whereas we were rather expecting to find some molten rock when we got down in there, we didn't. The rock had been cooled by this water that would make steam and the steam would go out and heat up some neighboring rock, porous structure, so we found that this whole sphere out to a diameter, a radius of about 130 feet and weighing about 400,000 tons was heated up by something like 40° F., I believe the number is, by the heat of this bomb.

Senator SYMINGTON. 40° F.?

Mr. LIBBY. Something like that.

I could leave for the record a rather detailed report on that, if you would care to have it.

Senator PASTORE. I do not see any harm in putting it in the record. I think it is quite important.

Mr. LIBBY. It is going to be released, or unclassified, in a speech that Dr. Gerald Johnson, who conducted this operation, will make next week, if you just won't release it before he gives his speech. (See appendix I.) It would be nice reading as background for this. I think it is March 10, he gives his speech, but it is sometime next week he gives his speech.

Senator WILEY. When you say it was pulverized, the mountain was pulverized?

Mr. LIBBY. I want to point out, Senator Wiley, it was a pretty easy mountain to pulverize, but the rock was pulverized. We couldn't retain drilling water as we came down from the top. Prior to hitting this pulverized zone we could pump drilling water into the well and keep going.

Incidentally, drilling water was hardly necessary below it because you could practically push through it, but you couldn't pump enough water in it to keep any pressurehead on it at all.

PEACEFUL USES OF NUCLEAR EXPLOSIONS

From all this, I think we learn that we have great potentialities in nuclear explosions themselves, the possibilities of making atomic power. If we had a dry mountain the conductivity of the rock is practically zero, that is a hot rock, a molten rock will conduct heat, but a hot rock that is solid will not.

This is what firebrick is made of. That is the way you insulate furnaces, and the temperature gradient in the earth shows this.

So if we have a dry mountain, we should be able to maintain the heat at a sufficient concentrated form so that we could pump water down in there and make steam.

Now we have in mind doing just this kind of thing. We call this Project Plowshare, and we are going to try to develop the nonmilitary or peaceful use of atomic nuclear explosions of which one is atomic power.

We have others. We know, for example, from our experiences already that we can make harbors. You have perhaps all seen some of the cavities we have made in the Pacific. Of course, these at the present time could only be made in remote areas for the simple reason that the fallout is so bad that we would not dare do it, though if we use some of our cleaner bombs, the fallout is much reduced, and so this points up further developments of the weapons of the nuclear test devices will allow us to clean up the smaller ones and then we may be able to move earth even in more populous areas. The cost of moving earth by this device, except for the fallout, is pretty low.

Senator PASTORE. Doctor, may I interrupt you at this time?

Mr. LIBBY. Yes.

EFFECT OF TEST SUSPENSION ON PEACEFUL USES

Senator PASTORE. Are you actually saying that agreement to suspend testing for a period of 2 years will deter the peaceful development of the atom? Is that the point you are trying to make with this exploration here?

Mr. LIBBY. I am trying to point up here that whereas people are always aware of the bad aspects of atomic bombs, people are not quite so aware that there are potentialities of atomic explosions which may be very good.

Now I would hope that any disarmament agreement, any, would specifically exempt the nonmilitary use of atomic explosions.

Senator PASTORE. Couldn't this be done with safety?

Mr. LIBBY. Certainly.

Senator PASTORE. I mean by agreement?

Mr. LIBBY. Yes, certainly.

Senator PASTORE. Let's assume that we were able to negotiate a foolproof agreement with the Soviet Union——

Mr. LIBBY. Right.

Senator PASTORE. On the cessation of testing for 2 years, and it became necessary, let's say, in the research and the development of peaceful use of atomic energy that such an experiment could be made. Why couldn't an exception be made here with the proper paper and a proper presentation as to what we propose to do and have it prop-

erly supervised, without giving away our secrets as to our technology, and at the same time carry on an experiment such as you have just indicated?

Mr. LIBBY. Governor Stassen always had this in mind when he was working on the negotiations. You know the Russians, the first thing they ever said about bombs, you will remember, they said, "We are moving mountains."

As far as we could tell, they never did any of that, but they talked about it.

Senator SYMINGTON. Mr. Chairman, I would ask a question.

Dr. Libby, it is always a pleasure to hear you.

Mr. LIBBY. Thank you, Senator.

DETECTION OF NUCLEAR TESTS

Senator SYMINGTON. We have a problem which is becoming a national problem, whether we can or cannot suspend testing by mutual agreement without danger to our security. I notice Dr. Teller, on Meet the Press, Sunday, talked about this, so millions of Americans are now thinking in their own minds about whether we should or should not suspend testing.

Dr. Teller was emphatic that we could not reach any agreement which the Russians could not cheat on, even in megaton bombs.

If I follow you, if most of the energy resulting from this explosion, like a crushed eggshell, went down, that is but further illustration that there would be excellent possibilities for cheating; is that not correct?

Mr. LIBBY. As far as fallout is concerned, it took us 4 months to find the fallout from this little bomb when we knew exactly where we fired it. Of course, we were scared and we went at it very cautiously. We went in very cautiously, but it took us 4 months to the day, I believe, before we located the eggshell, the broken fragments of the bubble.

Senator WILEY. How did that bomb compare with the bomb in Hiroshima?

Mr. LIBBY. About one-tenth the size, Senator Wiley.

Senator WILEY. It was that small?

Mr. LIBBY. That small.

Senator SYMINGTON. Here is a paper by Prof. Jay Orear, just put in front of me. Orear apparently believes in the possibilities of suspension of nuclear testing. But, from what you say, we would be taking quite a risk if we did.

Mr. LIBBY. Of course, Senator Symington, there are other ways of detecting bombs than just the fallout.

Senator SYMINGTON. Do you agree with Dr. Teller that we should not get into any testing agreement because of the danger of the Communists cheating on us? I think that is about the most important matter for world decision at this time.

Mr. LIBBY. Let's consider for a moment the problem of test inspection and the possibilities of cheating.

As I have said, if you fire underground, and Ranier Shot, that is, this 1.7 kiloton shot, is typical, as we think it is, it is possible to test with no fallout.

DETECTION BY SEISMOGRAPHS

It is possible to fire bombs with zero fallout. You still have the earth shock though, and so the thought is you could place seismographs on a gridwork.

Senator SYMINGTON. How would you know it wasn't an earthquake?

Mr. LIBBY. That is a good question, Senator, and this is a very difficult one, particularly when you get to small yield weapons like the 1.7 kiloton. Ranier was detected. I would submit for the record if you wish the stations which observed this earth shock from the underground test, Ranier Shot in Nevada, and the ones that missed it. I think it might be interesting.

Pasadena saw it and Berkeley saw it. They have good seismograph stations, and roughly that distance around. They were looking for it, and they recognized it and were certain it was Ranier.

However, I was in Paris at a UNESCO meeting at that time and was broadcasting to all of the 54 countries there, "Please go listen. We are going to fire this bomb at 6 o'clock tonight." Of course, it had to be delayed three times, to the great embarrassment of us, for no reason I can figure out, because weather doesn't play any role. We were just scared, I think, and they delayed it.

Finally, on the third day, they fired it. But people were listening. So it wasn't that they weren't looking. They were listening. So this list of stations which saw it was quite a good test of how sensitively you can pick it up. [Appendix II.]

Now the problem is how do you know—you see, they knew the exact time, so when it came at that instant they were pretty sure it was Ranier. [Deleted.]

However, when you get too far away from them, the difference is fuzzed out and you cannot be so certain.

Now the uncertainty about the difference between the nuclear and the natural earthquakes of course gets greater the smaller the shock. With a big bomb, the big shot, the difference would be detectable at a longer range, so the gridwork required to detect a megaton subterranean shot would be different from the gridwork required to detect a 1.7 kiloton shot.

Now suppose you had your gridwork all set out and you saw something. Presumably from the stations, the various stations, you could triangulate and locate roughly where it was.

Senator SYMINGTON. Mr. Chairman, may I ask a question there?

Senator PASTORE. Go ahead.

Senator SYMINGTON. Let's take a one megaton bomb—carefully prepared for cheating, with a great deal of money spent, say, in a deep mine shaft in a place like Siberia? Would you say for sure we could detect that over here, and decipher it, as against it being the result of an earthquake?

Mr. LIBBY. I am told it would be extremely difficult.

Senator SYMINGTON. Thank you.

POSSIBILITY OF DETECTION WITH GROUND INSPECTION

Senator PASTORE. Yes, but would that be effective? Would that be necessary—let me put it this way: Would that be necessary if you had

an agreement that would call not only for a cessation, but also with ground inspection?

Mr. LIBBY. Well, with the plan of being able to establish stations on a gridwork, and then also have the right to go examine any suspicious area, you would have in theory the possibility of detection. But suppose you localize where this thing went off? That area in which we fired this bomb is a pretty big thing, and a certain area might be 5 miles in diameter. As I say, it does not change the surface. It moved a few rocks, but the sagebrush is still there. If you were not watching at the instant the shot went off, you would not have known there had been a bomb fired under it.

Senator PASTORE. Let me get this straight now. Even if you did have ground inspection and you notice something on the graph that would be suspicious, you say that even if you went there to make the inspection, unless you did this drilling that you are talking about, you wouldn't know what happened underneath there.

Is that what you are saying?

Mr. LIBBY. By present technique, yes. That does not mean it is impossible. What I am saying is, it is very difficult.

Senator BRICKER. Could you tell us what would have happened if they had put a megaton bomb in there?

Mr. LIBBY. At that depth?

Senator BRICKER. Yes.

Mr. LIBBY. It would have blown up.

Senator BRICKER. Blown the whole mountain up?

Mr. LIBBY. Yes.

DEVELOPMENT OF WEAPON WITH REDUCED RADIOACTIVE FALLOUT

Senator BRICKER. One other thing that I would like to correct here if it is an error. Dr. Teller's position was not taking the assumption that we could not detect the Russian explosions at all, but his position was that we should not cease testing based upon the fact that much development is being made in the bomb by the testing, and particularly in the field of the cleaner bomb that we have got at the present time, and second that there are great peaceful uses, information secured by the testing of the bomb.

I think that was his position before our committee, wasn't it?

Mr. LIBBY. Yes.

Senator PASTORE. And I can corroborate that. Even in my personal talks with Dr. Teller he sees a great deal of promise in cleaning up the bomb to be used for peaceful pursuits.

Senator BRICKER. He even went so far as to say we can develop a clean bomb which would be a great deterrent to fringe wars, sporadic breakouts.

DEGREE OF EFFECTIVENESS NECESSARY IN INSPECTION SYSTEM

Mr. LIBBY. Yes, I agree with him on that. I probably am not quite so pessimistic about the possibility of detection, but I am pretty pessimistic. It is a pretty tough job. However, there will be many doubtful cases even if no one intends to cheat. It is difficult to know what we do if there is an argument.

Senator PASTORE. But don't we talk in paradoxes when we open up these statements by saying that we should explore every avenue, we should not resist speaking about these things, we should cooperate in having these conferences, we should do this and we should do that, and then we end up by saying well, you can't do it anyway. Where does that put us?

Mr. LIBBY. I haven't said you can't do it. I just want to say it is very difficult. It would be quite a task. However, I do think that it is clear that an inspection system does not have to be perfect. It seems to me that it is merely like ordinary criminal law. The chances of being caught if they are good enough, that is all you need. So I mean test inspection, though difficult, may be practical.

Senator SYMINGTON. Mr. Chairman, I want to emphasize how interested I am in complete and extensive pursuance of this whole disarmament picture, and am not questioning in any way the fact that we should go ahead to the best of our ability in trying to work something out.

I think we made a bad mistake in not going ahead with the testing suspension proposal investigation, by hanging on a production sine qua non stipulation, as Senator Humphrey brought out in his recent talk, but I think we ought to know the risk.

As to what Dr. Teller's position is, I will have the record here in a minute, and say to my distinguished friend from Ohio, if I am wrong I stand corrected——

Senator BRICKER. I did not hear that at all. I was talking about his position.

Senator SYMINGTON. I have talked to Dr. Teller at great length about this many times, only last week, about his position, and will know in a minute.

Senator BRICKER. What is that position?

Senator SYMINGTON. That it would be dangerous to enter into my agreement with the Communists at this time to stop testing.

Senator BRICKER. I think that is true. He has taken that position all along.

Senator SYMINGTON. I know he has also taken a position on the clean bomb, terribly important to us if we want to use nuclear bombs defensively. I also think he is worried because he does not believe we could check accurately the carrying out of a testing agreement on the part of the Soviet.

AREA OF DEVASTATION CAUSED BY LARGEST BOMB

Doctor, there is another question I ask. About 3 or 4 years ago you appeared before a Committee on Civil Defense.

Mr. LIBBY. Yes, sir.

Senator SYMINGTON. And you made a statement at that time. As I remember, you said the area of total devastation of the largest megaton bomb we had fired, presumably the one in 1954 which created the crater at Bikini, the radius of total destruction was 4 miles. Is that right?

Mr. LIBBY. I think that is about right, Senator Symington. I would have to check the figures.

Senator SYMINGTON. That would be an area of about 48 square miles, total devastation, would it not?

Mr. LIBBY. Yes, sir.

Senator SYMINGTON. That is more devastation than other statements I have read. I was wondering——

Mr. LIBBY. I will tell you the source of the material is unclassified. It is in The Effects of Nuclear Weapons, this second edition.

Senator SYMINGTON. That was an open hearing you had that day on civil defense.

Mr. LIBBY. Yes.

Senator SYMINGTON. Would you be good enough to check that figure and see if there is any change in it?

Mr. LIBBY. I will.

Senator SYMINGTON. Thank you, Mr. Chairman.

INSPECTION OF PRODUCTION OF FISSIONABLE MATERIAL

Mr. LIBBY. We have also had much discussion of the matter of inspection for the production of nuclear materials, and while our national proposal in that respect calls for the cessation of the production for warlike purposes, I want to emphasize that the inspection to insure compliance would involve close supervision of the entire process of all production from the beginning to the end application of the material. I believe it is generally agreed that this is a very difficult problem, and certainly is more difficult than the problem of inspecting test suspension.

Senator PASTORE. On that question, Doctor, let me ask you this question: While it would give you a better base for security if you had the two—that is, inspection as to production of fissionable material plus this cessation of tests—are they so related to one another that one perfects the other, or do they stand independently but together they give you more assurance?

RELATION OF PRODUCTION AND TESTING

In other words, is an inspection of fissionable production any part of cessation and inspection for cessation of testing?

Mr. LIBBY. They are not too directly related. The position of our Government, as you know, is the real danger is nuclear war in the use of the bombs. As I understand it, this is the reason we are so insistent on the matter of controlling production.

It seems to me that there are possibly intermediate positions here. You see, as people develop nuclear technology, we realize there is so much to be learned by further tests that there is a great danger that we will be losing a great deal and the human race would be losing a great deal if it is flatly agreed that work in this direction is to be stopped. Therefore, I would hope that whatever the agreement be, the nonmilitary use of nuclear explosions could be carried on under the disarmament authority or whatever body was controlling it.

RELATIVE EFFECTS OF PROPOSALS ON UNITED STATES AND U. S. S. R.

Senator PASTORE. Wouldn't that depend on whether we were ahead or behind? I mean, if you stop all production of fissionable material now, and you stopped all testing—let's assume that you could do it

effectively, I am not getting into that at all, but let's assume that you could—wouldn't it be advantageous to us to enter into such an agreement if we were ahead? If we were ahead in our arsenal of bombs, nuclear and thermonuclear, as against the Russians, if you stalemated it now, wouldn't we be in a better position than they would?

Mr. LIBBY. Our armament is stronger and is more varied and it is more developed than theirs, by a large factor.

Senator PASTORE. Therefore, if you could stop this thing cold as of now, wouldn't we be in a better position than the Russians? I mean let's assume that you could.

Mr. LIBBY. Our armament would be better. One of the questions is whether they would abide by it.

Senator PASTORE. I am not getting into that at all. We are discussing the point here whether it would be advisable to stop. I think it would be very advisable to stop if you could stop. Our question is, Can you stop?

Mr. LIBBY. I think there may be an intermediate position. One of the points that worries people about testing is the fallout hazard, and as I have indicated to you, it is possible to rigidly limit the fallout hazard. I have described to you how we managed to test little bombs with no fallout, and you know we have developed bombs with intrinsically less radio activity, the so-called clean bombs, which depend more on the fusion rather than the fission reaction for their energy, and one of our purposes in continuing tests is to develop this further, especially to extend it to smaller yields.

POSSIBILITY OF TEST LIMITATION RATHER THAN SUSPENSION

It is therefore conceivable that one could think about a type of test limitation rather than a test ban, and that the test limitation turn on the matter of the radioactive fallout which is introduced into the atmosphere as a result of the test operations.

We could, as far as we know, do a great deal at the present time along the lines of underground shots of the so-called dirty bombs, and any surface shots which had to be done.

For example, there is quite a lot we need to learn in civilian defense about the effects of bombs on structures. In the last operation in Nevada, Operation Plumb Bob, we had a considerable number of experiments on the effects of the blast on structures, civilian defense structures, and the military also always has tests where they have tanks and various pieces of military equipment strewn around to see what happens to the military equipment.

These tests could be conducted, if we were to be successful in developing small clean bombs, with clean bombs with the radioactive fallout from these tests which necessarily would have to be surface bursts, would have to be done above ground in order to get the effect on structures, as you couldn't blow a house down if you had the bomb buried, we could do this with the cleaner armament, the cleaner bombs. So it is possible to think about a type of test limitation rather than test suspension which turns on the limitation of radioactive fallout.

It is a difficult problem——

DR. TELLER'S POSITION

Senator SYMINGTON. Mr. Chairman, as to Dr. Teller's position, I would like to read into the record a short question and an even shorter answer:

Mr. SPIVAK. Are you saying, Dr. Teller, then, as long as we cannot trust the Russians or as long as we won't trust them, that there are no methods that can be devised that are safe?

Dr. TELLER. This is my opinion, yes, sir.

Senator WILEY. Do you agree with that?

Mr. LIBBY. I would like to qualify it. I think that there is no method that is absolutely certain, but I would at the same time point out that it may not be necessary to have a method that is absolutely certain in order to make the suspension workable in that the chances of detection of the violation, if they are large enough, this may be adequate.

Senator WILEY. I think the question should be asked first whether or not there is an effective way to ascertain whether they are exploding these bombs. That is the first one. The next one is the old question of Hitler, or the Kaiser, when he said a treaty is but a scrap of paper, so it is a question of moral responsibility of those you make a deal with.

Mr. LIBBY. That is right.

ENFORCEMENT OF TEST SUSPENSION

Senator WILEY. I would like to get your reaction on both sides, because to me that is the simple issue in a nutshell.

First, if they agree to stop testing, could you find out if they have violated it? If the answer is no, you couldn't tell, that settles that. But, since from our own experience of some 52 agreements with them, they have violated 50 of them, what is your personal opinion as to whether you can afford to enter into any agreement with them that might operate to the detriment of our own safety.

That is the big thing in my own mind. It is like trying to argue with a wild animal. If they won't listen, or if they do listen, they won't follow through on what they agree. There isn't any need of trying to argue.

Mr. LIBBY. I think you are correct in dividing this question into two parts. First, on the technical matter of whether you could develop a system to enforce a test ban, I think you can do this. You can develop a system which is good enough. It is a much more difficult job than some people have indicated, but you can do it to the point where it will be good enough so that the chances of being caught are big enough so that it probably would be adequate. But you cannot, in my opinion, devise a system which you can be certain will detect every shot, particularly if the yields are very low.

Now on the second point, as to the probability of their violation, I certainly have no competence in this field. It seems to me that their record is not very good, Senator Wiley, in this respect, and so I think to have a disarmament agreement, we certainly should have inspection built into it, an inspection that is adequate.

Senator WILEY. Of course, if you make an agreement and you do not keep your own powder dry, you may have another Pearl Harbor.

Mr. LIBBY. Yes.
Senator WILEY. Then where are you?
Mr. LIBBY. That is right.

POSSIBILITIES OF DETECTING TESTS

Senator BRICKER. If Russia had exploded a kiloton, 1.7-kiloton bomb, as we did, in middle Russia somewhere, is there likehood that we could have detected that anywhere?
Mr. LIBBY. You mean underground?
Senator BRICKER. Yes.
Mr. LIBBY. I think we would have missed it.
Senator BRICKER. Missed it?
Mr. LIBBY. Yes, underground. Yes, I think we would have missed it. [Deleted.]
Senator SYMINGTON. But the proposition has not always been that we would put various stations around. At one time there was a large segment of people in this country whose idea was we should agree to stop testing, then wait and see if they did, too.
Senator BRICKER. Several thousand scientists signed a circular to that effect.
Senator SYMINGTON. Yes. As I remember it, many people felt that was a wise plan. I was willing to go for it, provided we were absolutely certain, if they cheated, we could find it out. The fact it is being constantly suggested we originate cessation of testing worries me, unless we are sure we can find out whether or not the possible enemy could be cheating. I do not say Dr. Teller is the law of the Medes and the Persians, but he is an educated man in this field. Therefore, when he makes such a flat statement, the one I just put in the record, it increases my apprehension, about any bilateral agreement.
Mr. LIBBY. I think you see from my remarks, Senator Symington, that I am pretty close to Mr. Teller's position.
Senator SYMINGTON. Yes.
Mr. LIBBY. However, I think there is this point: That it does not have to be absolutely perfect.
Senator SYMINGTON. My only reservation would be, I think the distinguished Senator from Wisconsin used the term, "Pearl Harbor." If you made one more mistake of that character, you would never have a chance to make another.

EFFECT OF TEST SUSPENSION ON PEACEFUL USES

Senator BRICKER. May I ask another question?
If we could get an ironclad agreement, enforcible, to cease testing at the present time, what would be the loss to the peaceful use of atomic energy?
Mr. LIBBY. May I ask, Senator Bricker, whether this agreement would contemplate having the peaceful uses developed under the aegis of the disarmament authority or would it be cessation of all explosions under all circumstances?
Senator BRICKER. Cessation of all explosions, would we lose a great deal in making progress in its peaceful uses?
Mr. LIBBY. Yes, it is my opinion that we would lose a very great deal. I really believe that the nonmilitary applications of atomic ex-

plosions, nuclear explosions, are going to be of great benefit to mankind. I named only a few in my previous remarks of the possible applications. There are numbers of others, not only on atomic power, and the possibilities of moving earth, but the possibilities of loosening up underground structures. You take an old oil field that is essentially useless because the pressurehead is lost or the oil will not flow to the drill hole. There are possibilities, and American industry, several industries in this country, are now in touch with the Atomic Energy Commission, several oil companies with the suggestion that we join together in a cooperative enterprise to see whether a bomb—I shouldn't call it a bomb, but a nuclear device—placed underground in these old fields and fired, wouldn't sufficiently loosen up the structure so that they could get more oil out of this. This is a possibility which is interesting to a number of oil companies.

We can also make isotopes. I told you how all the fission products were caught in these black molten rocks. Well, we can take those rocks out and dissolve them and we can get out of them whatever isotopes would have been made in the bomb and in materials immediately surrounding the bomb. So there are definite possibilities of making isotopes this way.

There are also other things. For example, it would be very interesting, I think, to see what would happen in a thick coal seam if you fired a bomb in it, the chemical effects, which might be interesting, and the widespread heating.

Well, there may be others, and this is such a new thing that we hesitate. I believe most people hesitate to say that we are not going to proceed further. However, it is conceivable to have an arrangement under which this kind of further investigation could be conducted under the aegis of the disarmament authority, the United Nations, or whatever organization is given the job of administering the disarmament arrangement. But I certainly think our loss would be very great if we decided that we were never to fire any more nuclear explosions under any conditions.

We have learned a great deal. Our Sherwood project for the development of control of thermonuclear energy. Look, we all know that is possible in the sense that we know we can release an enormous amount of energy because of the fact we have actually fired hydrogen bombs. We know we can get the energy out of hydrogen isotopes because we have done it. The only question is whether we can do it in a controlled fashion. So essentially the hydrogen bomb has put a firm base for what may be one of the most important peaceful applications of the atom, namely, burning the sea water to make power. There are a number of examples of this sort. So I think it would be extremely unwise of the world to forever ban all nuclear explosions.

RELATION OF TESTING TO WEAPONS DEVELOPMENT

Now the importance of testing to our armament is very, very great indeed. We need the testing of actual bombs, and now I do mean bombs, that is actual weapons, because of their extreme importance in the details of their structure to such matters as the delivery.

We have had, for example, in 1945, no understanding of the nature of the ICBM delivery detail, so the bombs that we had at hand at that time were completely unsuited to serve as warheads in an intercontinental ballistic missile, and we still have to test.

That is, the matter of size and shape and weight is a pretty important thing in these delivery systems, and when we make changes in these, we have to be sure that the thing will work.

Now the most dramatic thing we have done in many ways in the last 2 or 3 years has been the cleaning-up process, that is the reduction of the fission products by the increased use of the fusion reaction.

This cleaning-up process makes it possible for us to have an armament in which a campaign could be conducted where the effects were really localized. At the moment, these things are present only in the larger yields, and if we can get tactical cleans, this is going to be a possibility of real importance.

This brings up a question that I think is important in connection with the test ban, namely, whether we think about the military use of nuclear weapons in limited warfare.

It seems to me conceivable that nuclear weapons can be used in limited warfare without starting the worldwide holocaust. It has been called to my attention that there is a definite possibility, for example, that a small nuclear weapon used in antisubmarine warfare might not necessarily set off a worldwide holocaust. There are various situations of this sort where small weapons—some of our small weapons, this 1.7 kiloton is only a slight bit larger than some of the ordinary chemical bombs that were developed and used during World War II. So the spectrum of yields in the nuclear arsenal sort of overlaps the chemical.

Senator SYMINGTON. What is the weight of a 1.7 bomb?

Mr. LIBBY. It is pretty small, and this is highly classified. If you want it on the record, I can put it in, Senator, but I do not really know.

Senator SYMINGTON. Keep it off the record.

(Discussion off the record.)

Mr. LIBBY. We have reasons for developing this small bomb armament in our normal military police operations, and we have a long way to go in cleaning up this part of our armament. So this is a pretty commanding reason for further testing.

But fundamentally it is this point. That we cannot make the improvements in our military machinery which has come to depend in large part for explosive power on atomic and nuclear weapons, we cannot make these improvements without testing.

And so if you stop testing, you are stuck with and you have the present arsenal and that is just about it.

I do not believe that you would dare go forward and make a whole system and a whole war plan depend on some untested modification of something you do before.

RELATION OF TEST SUSPENSION AND MISSILE DEFENSE

Senator SYMINGTON. I would like to read into the record a short statement on that from Dr. Teller's recent telecast, confirming what Dr. Libby has said. [Reading]:

Mr. RESTON. Dr. Teller, on the question of using nuclear energy for defense, can you tell us anything about the antimissile missile, what possibilities are of using the atomic explosion to stop missiles coming into this country?

Dr. Teller says:

I can say this. If you eliminate nuclear explosives, then you make the antimissile defense an insoluble problem.

Mr. LIBBY. I certainly would agree with that statement. The radius of effectiveness of any other explosion is too small.

Well, if we had to stop testing years ago, we would be far behind our present position, and so it seems to me that there are two commanding reasons for continuing. In the absence of a safeguarded disarmament agreement, we can ill afford to give up weapons testing, and we absolutely cannot afford to give up the development of nuclear explosions for peaceful use.

Now I do not think these are the same things. I think it is not unlikely the Russians would agree and we would agree to carry on peaceful developments under the aegis of disarmament authority, but there are these two points which are absolutely vital.

Senator SYMINGTON. I want to be clear. How could you agree that explosive testing would only be for peace, and not be for war, or vice versa, any more than you could agree that satellites now going around the world are peaceful, without knowing what those satellites contain?

Mr. LIBBY. Well, if we had the disarmament authority in charge of the proceedings, of course it would presumably——

Senator SYMINGTON. Your premise is mutually agreed upon, foolproof application. Is that it?

Mr. LIBBY. It would seem to me to be practical.

Senator SYMINGTON. Would that be the premise of your statement?

INFORMATION ON RAINIER SHOT

Mr. LIBBY. Right. There are two kinds of applications. For example, we talk very freely about this Rainier shot. We use what we call the black box on it. All we tell people is that this was a bomb. We do not tell them how big. We show them the tunnel. The tunnel is about 7 feet tall and about 6 feet wide, so all they know is the bomb is smaller than that. Then we say the bomb was here and went off with a 1.7 kiloton yield.

Now in all the discussions we have had, and we have had many of them, the geologists and oil people, scientists, seismologists, all sorts of people, they have never once complained that there was something that they needed to know which we could not tell them, because the problems that have come up so far in this have been all answered by the fact that it was a bomb of a nuclear variety and therefore, went off quickly, was small. They do not need to know how big.

Now there are other possible applications. For example, in this matter of improving old oilfields, we might have to tell them how big a hole to drill. This gets a little touchy as to just how big the bomb is.

Senator SYMINGTON. Where is the danger in telling them how big the bomb is?

Mr. LIBBY. It does involve weapons design information. It was quite a job to make these bombs as small as they are, and naturally it costs less money to drill a 9,000-foot hole if it is this diameter as compared to this diameter (indicating). So in some of the peaceful applications we would not get away completely with the black box concept.

So far most of it, we will get away with the black box concept.

Senator SYMINGTON. Everything gets smaller. Three years after we were using 10 pounds of copper in the voice coil of loudspeakers we were using a third of a pound, and producing a better speaker. The

Russians must certainly be making their bomb smaller. What is the great apprehension about it. Everybody knows that the first atomic bomb was designed for the bomb bay of a B–29.

Mr. LIBBY. Right.

Senator SYMINGTON. I cannot figure it out, why it is so important to highly classify the weight of a bomb. The Russians have shown pretty conclusively fairly recently that their technological progress in these fields is not lacking.

Mr. LIBBY. That is an isolated example. I think for most of the peaceful uses you could conduct them under a disarmament authority without revealing anything.

Now to say, however, that in doing that you have not learned something might be a little difficult. But I think you can come close enough, it looks feasible enough so certainly we ought to bear in mind if we have a disarmament agreement, we exempt the nonmilitary applications.

Senator SYMINGTON. Defense Secretary Quarles said last month—

> We believe there are no important areas of nuclear technology known to the United States that the Soviets will not be able to obtain through their own efforts.

Secretary Quarles is pretty knowledgeable on matters of research and development.

Mr. LIBBY. Yes, I agree with that. [Deleted.]

What we are worried about is that agreement which we certainly will obey and honor, they may not. And so the question is how can you be sure, how can you inspect so that you are certain they are not violating anything. I think that is the question.

Senator BRICKER. May I be excused? I have to catch a plane. I am going to Ohio. I would like to hear the rest of this, but I see that the Commissioner is almost finished, and I do think your contribution has been very much worthwhile this afternoon. I have been tremendously interested. Will you excuse me?

WEAPONS ABILITY OF SOVIET UNION

Senator SYMINGTON. There was a time when this Government felt the Russians could not possibly build a good fighter plane. When we went into Korea we found they had turned out the best in the world at that time.

Mr. LIBBY. Right.

Senator SYMINGTON. Then they turned up with the best light jet bomber in the world, in fact the only one. When we were asked for money on the Appropriations Committee last fall for the satellite, it was on the ground, we wanted to be sure we were first with a satellite.

That is all in the printed public record. So I wonder how we know so much about how far ahead we are in the atomic field.

Mr. LIBBY. I do not want to labor this. Look, the Russian armament is entirely good enough to annihilate us.

Senator SYMINGTON. I am only trying to learn, and I do not mean to labor it at all.

Mr. LIBBY. That is very clear. But there are certain things we think they do not know, which are quite important. But theirs is awfully good, awfully good, and Secretary Quarles is right. There

is no evidence from having seen them do the difficult things they have done that they cannot go the rest of the way up to where we are, and maybe pass us.

I think if we have a test ban and they violate it and we don't, they will pass us, and this is what worries me as much as anything else. So the whole thing turns on the matter of inspection, and I certainly feel completely convinced that we have to look at the matter of the suspension of production as being very, very important, even though it is much more difficult to control, because the real difficult thing is after you get these bombs made, there is no detecting them. They can be hidden.

RELATIONSHIP OF TEST BAN AND PRODUCTION CUTOFF

Senator SYMINGTON. Would you tie in production, then, always, with testing, before agreeing to test suspension?

Mr. LIBBY. This has been our position, of course, Senator, and I am personally convinced it is a correct one.

However, we should consider the possibilities, and I want to point out today that there is the matter of a limitation rather than a suspension, a limitation which does remove the fear of radioactive fallout essentially completely.

This could be done, and I think that is the important thing to bear in mind. It is probably that many people are too afraid of the amount of radiation that comes from testing, but nobody likes it, and as far as we know, it does nobody any good, and so testing with limited or essentially zero radioactive fallout would be an advancement as far as the health of the world is concerned, as far as the hazard from fallout.

However, whether it would be a major step toward total disarmament is another question. The psychology of banning the discovery of new things is a dangerous road to take, and we have to guard against that. I think that we ought to have learned that even the worst things have good aspects and atomic weapons are no exception to that rule.

If there are any other points about the matter which we could help your subcommittee with, we would be very pleased to do it. We will supply these items I have mentioned for the record.

Senator SYMINGTON. Yes, if you would. We are very grateful to you, and everybody will want to read your testimony. I think we are probably talking about the most important subject in the world.

Mr. LIBBY. I agree.

Senator SYMINGTON. It is something we have to decide, one way or the other, fairly soon.

I have always enjoyed listening to you.

Mr. LIBBY. Thank you, Senator.

Senator SYMINGTON. You express yourself well and have given us a lot of good information today. I know Senator Humphrey is sorry he could not be here; and I am sorry I was late. We are grateful to you for coming.

Mr. LIBBY. Thank you for inviting me.

(Whereupon, at 5:15 p. m., the subcommittee adjourned.)

(The following letter was subsequently submitted for the record:)

UNITED STATES ATOMIC ENERGY COMMISSION,
Washington, D. C., March 10, 1958.

Hon. HUBERT H. HUMPHREY,
Chairman, Subcommittee on Disarmament,
Committee on Foreign Relations, United States Senate.

DEAR SENATOR HUMPHREY: It was a pleasure to appear before your Subcommittee on Disarmament on Thursday, March 6. I am sorry to have missed the pleasure of testifying before you directly.

Upon thinking of the testimony it occurs to me that I should amplify it in one respect. This letter is for that purpose. I hope that you will find it possible to make this letter a matter of record with Thursday's proceedings.

Because as a scientist I visualize so clearly the unlimited horizons lying in peaceful uses of nuclear explosives I dwelt at some length upon these possibilities in my testimony last Thursday afternoon. So much so, that I may have implied that the matter of clean weapons is of somewhat lesser importance. This is by no means the case. It is my deep conviction that we must have clean weapons in all yield ranges available in our stockpile in large numbers. If not, all humanity will surely suffer to some extent if a major nuclear war occurs. There will be no alternative if tests stop completely.

I feel so strongly on this point that I would be most unhappy should the record of Thursday's testimony fail to show how important I consider these two elements to be.

Again, may I repeat my offer of any assistance the Atomic Energy Commission may give in your exploration of this major problem now facing the world.

Sincerely yours,

W. F. LIBBY, *Commissioner.*

APPENDIXES

Appendix I

Speech Given by G. W. Johnson, UCRL to AAPG Meeting on March 11, 1958

The purpose of this discussion is to report to you the technical results of a completely contained underground nuclear detonation and to suggest what to us seem to be reasonable possible nonmilitary applications. The results have been released in an unclassified report entitled "The Underground Nuclear Detonation of September 19, 1957—Rainier" by G. W. Johnson, G. T. Pelsor, R. G. Preston, and C. E. Violet dated February 4, 1958, which is now available for distribution.

The objective of the test initially was to develop a new nuclear device test technique which would eliminate offsite problems such as (1) radioactive fallout, (2) blast or noise, and (3) interference with airline traffic. Under such conditions the testing would not be subject to expensive delays due to unfavorable winds or other meteorological factors. At the outset it was clear that many experimental measurements, particularly those requiring massive shielding, could be readily accomplished underground. The principal questions were concerned with effectiveness of containment, depth burial, seismic effects, and ground water contamination.

A selected device of low-yield 1.7 kilotons was fired in a tunnel driven in the side of a mountain at the Nevada test site [slide 1]. The vertical depth of burial was 900 feet and the nearest point to the sloped surface of the mountain was 800 feet. The geological structure consisted of a cap 200 feet thick of welded tuff, underlain by several layers of bedded tuffs. The first few hundred feet below the cap was lightly cemented; however, at the depth of the tunnel the structure was sufficiently strong that no timbering was required in the tunnel.

The preshot physical properties of the medium are listed in the next slide [slide 2].

Density (in situ)—Sound velocity
Dry bulk density—Bulk modulus
Percent voids—Compressive strength 5,000–15,000 psi
—Specific heat
Water content—Thermal conductivity
—Chemical composition

[Slide 3] The tunnel was designed to be self-sealing, the basic concept being that the tunnel would collapse opposite the point of detonation before the shock could transport any material around the tunnel. The principal worry before the shot was the possibility of fissures developing either in the tunnel outside the region of collapse or to the surface which would permit the escape of radioactive products.

On firing the shot [slide 4 and 5] the tunnel collapsed out to 200 feet from the point of detonation—beyond that point for about 300 feet the tunnel was damaged but was passable. The remainder of the tunnel was intact. The radioactive material was completely contained—none could be detected on the surface nor in the tunnel above natural background. A drilling program carried out by Longyear to explore the shot area and to obtain radiochemical samples was instituted. The drill was modified to permit remote operation in the event that high pressure regions were penetrated. [Slide 6] One hole was drilled vertically from the surface directed at the point of detonation, and holes were drilled along three lines from inside the tunnel, also through the region of detonation. The lines are shown in slide 7. Radioactive samples were recovered and analyzed, and the holes logged for temperature and gamma radiation. Also gas samples were collected from various points. The results are shown in slides 7–8. (Temperature and gamma logs.)

From the radiochemical results it appears that practically all of the fission products except rare gases were trapped in fused glassy tuff. From these

measurements it was calculated that about 700 tons were initially melted. It was possible now to reconstruct generally what happened [slide 9].

Initially a cavity was produced with an inside radius of 55 feet. This was surrounded by a shell of fused material at 1200°–1500° C. about 4 inches thick. It stood long enough for fused tuff to drip from the roof because droplets 5–10 millimeters in diameter were recovered which had frozen in free fall and also short "icicles" 2 centimeters long were recovered. The cavity soon collapsed probably in a matter of minutes and successive caving proceeded to a height of 400 feet above the point of detonation.

Because of the dilution of cold rock falling from the roof and because of the presence of large amount of water, the temperature rapidly fell to the boiling point of water.

CONCLUSION

Seismic effects were very small so that explosions at least up two order of magnitude can be fired.

Ground water contamination appears to be negligibly small.

Possible applications are suggested because the explosion produced 200,000 tons of crushed permeable rock and 500,000 tons of crushed rock. Some suggestions have been (1) production of artificial aquifers for replenishing water tables, (2) breaking up of low-grade ore deposits prior to leaching, (3) breaking up and releasing of oil in oil shales in situ, (4) heating and loosening of tar sand oil deposits, (5) production of fill. You will be able to think of others. We have submitted a program to carry out a series of test detonation to get the economic and technical answers needed to further evaluate the above possibilities. I might add further that just in the course of carrying out weapons and device tests underground that additional information bearing on these subjects will be obtained.

APPENDIX II

Information from the United States Coast and Geodetic Survey on detection by seismic means of the September 19, 1957, detonation of the Rainier underground shot at the Nevada Test Site, as submitted by the Atomic Energy Commission on March 13, 1958.

MARCH 13, 1958.

Gen. ALFRED D. STARBIRD,
Director of Military Application, Atomic Energy Commission
Washington, D. C.

DEAR SIR: The seismograms and copies of seismograms of the Rainier explosion which are at present in the Washington office of the Coast and Geodetic Survey have been reviewed and a summary is made in the accompanying table.

In the column headed "Detection of P waves" the "X" indicates stations recording compressional wave arrivals which are of sufficient quality for accurate location of the event. Those stations which are marked "late" did not show compressional waves of this quality. The existence of shear waves on the record of a given station is indicated by the symbol "X" in column titled "S waves," and by "late" if the arrival is later than expected on the basis of the average travel time for this type of wave. Some stations either nearby or relatively distant may not have recorded or reported the blast because of the low sensitivity of the seismographs, excessive background noise, and geological factors.

The direction of first motion of the compressional or P wave at the recording station is indicated by an "X" if definite and "no" if it cannot be determined. Direction of first motion is of importance in distinguishing between explosions and earthquakes. Theoretically, explosions should send compressional waves in all directions from the source, while earthquakes send out compressional and rarefactional waves which are determined by the fault structure and which are recognizable as such at the stations.

Very truly yours,

CHARLES PIERCE,
Rear Admiral, Coast and Geodetic Survey,
Assistant Director.

Seismic detection of Rainier

Station	Distances kilometers [1]	Detection of—[2]		Direction of first motion	Data not yet evaluated
		P waves	S waves		
Tinemaha, Calif.	180	X	X	X	
Boulder City, Nev.	180	X	X	X	
Hoover Dam, Nev.	190	X	X	X	
Haiwee, Calif.	200				X
China Lake, Calif.	200	X	X	X	
Eureka, Nev.	260	X	X	X	
Isabella, Calif.	270				X
Woody, Calif.	290	X	X	X	
Fresno, Calif.	320	X	X	No.	
Big Bear, Calif.	330				X
Dalton, Calif.	370	X	Late.	X	
Mount Wilson, Calif.	370				X
Riverside, Calif.	370	X	X	No.	
King Ranch, Calif.	380	X	No.	?	
Pasadena, Calif.	380	X	Late.	No.	
Reno, Nev.	410	Late.	X	No.	
Palomar, Calif.	430	X	X	No.	
Mount Hamilton, Calif.	480	X	Late.	No.	
Barrett, Calif.	500				X
Palo Alto, Calif.	530	Late.	Late.	No.	
Berkeley, Calif.	540	?	Late.	No.	
Salt Lake City, Utah	550	Late.	X	?	
San Francisco, Calif.	550	No.	X	No.	
Mineral, Calif.	560	No.	?	No.	
Logan, Utah	630	No.	No.	No.	
Shasta, Calif.	660	X	?	No.	
Tucson, Ariz.	740	Noise.	Indefinite.	No.	
Pinedale, Wyo.	840	X	X	X	
Boulder, Colo.	1,000	Late.	No.	No.	
Corvallis, Oreg.	1,010	Late.	No.	No.	
Laramie, Wyo.	1,020	X	Late.	?	
Butte, Mont.	1,030				X
Bozeman, Mont.	1,030	No.	Late.	No.	
Hungry Horse, Mont.	1,250	Late.	?	No.	
Seattle, Wash.	1,260				X
Rapid City, S. Dak.	1,340	?	?	No.	
Victoria, British Columbia.	1,390	Late.	No.	No.	
Dallas, Tex.	1,830	No.	No.	No.	
Fayetteville, Ark.	1,970	X	No.	No.	
Central, Mo.	2,000	No.	No.	No.	
St. Louis, Mo.	2,200	No.	No.	No.	
Grand Marais, Minn.	2,400	No.	No.	No.	
Mammoth Cave, Ky.	2,600	No.	No.	No.	
Toronto, Ontario	3,200	No.	No.	No.	
College Park, Pa.	3,200	No.	No.	No.	
College, Alaska	3,700	X	No.	No.	

[1] 1 kilometer equals 0.6214 mile.

[2] All qualifying remarks except "X" mean that diagnostic information (that is, precise time and definite direction of first motion) is either not present, or, if present, remains uncertain. A question mark indicates uncertainty of timing or identification of the P wave or S wave, and "no" indicates the absence of a legible P wave or S wave trace. This list does not include all stations in the United States.

×

Data not yet evaluated
X
X
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of a legible

CONTROL AND REDUCTION OF ARMAMENTS

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HEARINGS

BEFORE A

SUBCOMMITTEE OF THE
COMMITTEE ON FOREIGN RELATIONS
UNITED STATES SENATE

EIGHTY-FIFTH CONGRESS

SECOND SESSION

(Pursuant to S. Res. 93, S. Res. 185, and S. Res. 286, 84th Cong., S. Res. 61, and S. Res. 241, 85th Cong.)

PART 16

MARCH 12 AND 25, 1958

WASHINGTON, D. C.

Printed for the use of the Committee on Foreign Relations

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NOTE.—Sections of this hearing have been deleted in the interest of national security. Deleted material is indicated by the notation "[deleted]." Material in brackets has been paraphrased to avoid revealing classified information.

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CONTROL AND REDUCTION OF ARMAMENTS

WEDNESDAY, MARCH 12, 1958

UNITED STATES SENATE,
SUBCOMMITTEE ON DISARMAMENT OF THE
COMMITTEE ON FOREIGN RELATIONS,
Washington, D. C.

The subcommittee met, pursuant to call, at 10:15 a. m., in the Foreign Relations Committee room, United States Capitol Building, Senator Hubert H. Humphrey (chairman of the subcommittee) presiding.

Present: Senators Humphrey, Green (chairman of the Foreign Relations Committee), Long, and Symington.

OPENING REMARKS OF THE CHAIRMAN

Senator HUMPHREY. The hearing today is a continuation of our study of the developments in the field of inspection and the methodology which might be pursued in obtaining effective inspection. We are very concerned with the cutoff of production of fissionable material for weapons purposes, one of the proposals in our disarmament package, how it could be properly inspected, and what would be its full import.

We are also concerned about the suspension of nuclear weapons tests with inspection. We want to know whether or not a test suspension would jeopardize our progress in the field of atomic weaponry, and whether or not it would jeopardize our security because of a possibility of cheating on the part of the Soviet Union.

Those are broad questions and statements, but we are going to direct our attention to them to see if we cannot build a body of information which will be of some guidance to the Congress.

We have with us for this hearing two officials from the Atomic Energy Commission, Gen. Alfred D. Starbird and Dr. Stafford English, who have special knowledge of vital importance in the discussion of disarmament.

As in the case of last week's hearing with Commissioner Libby, the hearing today is being held in executive session. It is our hope the AEC will be able to make available to the public much of the testimony. We always send the testimony back to the Commission for its editing so as to withhold any material which might be of a confidential or secret nature.

Our first witness today will be Gen. Alfred Starbird, Director of the Division of Military Application of Atomic Energy. I have asked General Starbird to direct his testimony primarily to the very important question of the possible effect upon our nuclear weapons program of the current disarmament proposals relating to nuclear weapons, especially a suspension of tests.

We are not a committee which is only indulging ourselves in the idealistic aspects of disarmament or in what is commonly known as the utopianism of a world which is completely disarmed, although this would be something we would like to achieve. We also are trying to get material and information which will enable us to talk about the realities of the situation rather than merely our hopes and aspirations.

It is on that basis that we seek this guidance which you men who are charged with these great responsibilities can give us. Please proceed now, General.

STATEMENT OF BRIG. GEN. ALFRED D. STARBIRD, DIRECTOR OF MILITARY APPLICATION, UNITED STATES ATOMIC ENERGY COMMISSION

General STARBIRD. I am General Starbird, Director of Military Application.

I was honored to receive your letter of the 5th, and I appreciate the great importance of the task you have. The problem you are studying is to me, and to most people, one of the most, if not the most, important issue that faces us today.

Your letter to me set forth five specific questions as being indicative of the information you would like to have from me. Those questions were excellently drawn, and I would like to repeat the questions first, and then go on, taking each question and answering that, if it pleases you.

Senator HUMPHREY. Yes. I am going to make note here in the record; we will print the entire letter so our record will be complete.

(The letter referred to follows:)

MARCH 5, 1958.

Gen. ALFRED D. STARBIRD,
Director, Division of Military Application,
Atomic Energy Commission, Washington, D. C.

DEAR GENERAL STARBIRD: The Senate Subcommittee on Disarmament is planning to hold a series of hearings which will cover the following subjects.

I. Review of disarmament negotiations, the disarmament debate at the U. N., and other major related developments.

II. The relationship of nuclear weapons tests and production to national security and the control of armament.

III. Control of missiles and outer space vehicles for peaceful purposes and their relation to disarmament.

IV. Controls and limitations on armaments in specific geographical areas and their relation to political settlements.

One of the most urgent questions under part II concerns the effect a suspension or cessation of nuclear weapons tests would have on our security. In view of your position, your views on the need for continued nuclear weapons tests would be extremely valuable. Therefore, I would like to invite you to testify before us, if possible on Wednesday, March 12, at 10 a. m. As I understand that much information in this field is classified, the hearing would be held in executive session, with the hope that some parts of the testimony, with your consent, could be made public later.

We would be interested in your views on the purposes that future nuclear weapons tests are expected to serve. What would be the effect of a weapons test ban or suspension on the development of long-range missiles? What would be its effect on the development of nuclear weapons with less radioactive fallout? What would be its effect on defensive measures? Are nuclear weapons yet ready for defense in "local" wars? This is the type of information we are seeking. However, we would be happy to receive any views you have on the control of nuclear weapons.

I hope that you will find it possible to testify. A member of the subcommittee staff will be in touch with you.

In order that you may know of the composition, work, and interests of the subcommittee, I am having sent to you under separate cover its most recent report.

Sincerely,

HUBERT H. HUMPHREY.

Senator HUMPHREY. You go right ahead.

General STARBIRD. The first question was: What is the primary purpose that our nuclear weapons tests are expected to serve?

The second question is: What would be the effect of a weapons test ban or suspension on the development of long-range missiles?

The third question: What would be its effect on the development of nuclear weapons with less radioactive fallout?

The fourth question: What would be its effect on defensive measures?

And the fifth question: Are nuclear warheads yet ready for defense in local wars?

To give you the sound answer to the questions, I must make the testimony secret. I will take the testimony back, sir, as soon as it is available, and edit it and take out the classified matter, making available then to the committee both the unclassified and the classified versions.

Senator HUMPHREY. Thank you.

General STARBIRD. Taking first, then, the question: What are the primary purposes to be served by further testing? These purposes are basically four:

TESTS TO IMPROVE WARHEADS

Firstly, future weapons tests will be designed to develop warheads for the more advanced weapons systems, warheads we don't now have and don't know now how to make.

Incidentally, when I use the term "warhead," I shall use it as meaning either or both a bomb or a warhead to go on a missile. We refer to these both as the warheads.

Senator HUMPHREY. Yes.

General STARBIRD. We have learned in the last 4 years that we should be able to make very small warheads, warheads much, much smaller than we were able to make in the past and can make today.

We have learned also that we should be able to make warheads which [deleted] have a [deleted] greater explosive value for the weight concerned.

We know also that the Soviets in recent years have made excellent advances in the field of delivery systems.

This, then, has led us to restudy and redefine the systems which we will use.

We now require systems of smaller size, capable of being deployed in areas and with organizations that did not have them before.

We require also that these be immediately ready, as we say it. Nothing is immediately ready, but we mean then ready in terms of minutes instead of in terms of half-hours or hours or even days.

We require systems that are much more rugged than the past systems. You can imagine that a system, for example, to go on a ballistic missile which must stand the shock of takeoff, the heat and cold of passage, must be entirely different from the type which was carried

a few years ago and is now carried in a bomber that is just going through.

Now each warhead design must be tested if we are to rely on it in case of emergency.

We can make minor variations in an existing warhead, but we fear making a big variant without running through a test.

Just to give an example of why we fear it, in this last series we had some 25 shots that we fired. True, we designed them near the optimum; but of the 25 shots, [a few] did not live up to the hope and expectation. The best of brains with these things cannot design them so that they can be positive they will work in an emergency without some form of test.

Therefore, to cut off testing would cut off the introduction of many new or substantially improved systems in time into the stockpile, systems the Department of Defense desires.

I shall not discuss any more this particular purpose now, but I will come back to it in connection with the other later questions, and there discuss the specifics of the effects on particular systems.

TESTS TO REDUCE FALLOUT

Now the second purpose of future tests, and one perhaps of equal importance with the first, to us, is the furtherance of the developments of weapons of greatly reduced fallout. In the future discussion today on this matter, I will refer to these as being clean weapons, though I should emphasize that as of now we see no way of making a weapon completely clean, that is, clean to the extent that it has no residual radioactivity.

Yet it appears entirely possible to reduce the area of fatal radioactivity to approximate the area of fatal blast and burn. In other words, to pull it down so the radioactivity has the same basic area of fatal hazard as you would have from that size of weapon for burn or for blast.

[Deleted.]

Senator SYMINGTON. Mr. Chairman, may I ask a question?

General STARBIRD. Yes.

Senator HUMPHREY. You do not mind being interrupted in your testimony?

General STARBIRD. No.

Senator HUMPHREY. Fine.

Senator SYMINGTON. It is true, is it not, that if you have a fission situation you may have more dirt than in a fission-fusion bomb?

General STARBIRD. Relatively, this is true, because from a fission bomb all of the reaction gives dirt, the dirt being residual radioactivity. From a fission-fusion bomb, one that is part fission and part fusion, the fission is the element which gives most of the residual radioactivity.

Senator SYMINGTON. And you have a chance of eliminating the fission in the fission-fusion bomb?

General STARBIRD. You continue to reduce it, sir. I do not know whether we will ever get to a point where there will be zero fission.

Senator SYMINGTON. If you eliminate the trigger aspect of fission in a fusion bomb, and get your required heat in a different way, then you automatically get a cleaner bomb; do you not?

General STARBIRD. This is correct, sir.

Senator SYMINGTON. You talk about weight. What was the weight of the bomb dropped in this mountain explosion, which has now created quite a lot of interest?

General STARBIRD. The weight of that was approximately [deleted].

Senator SYMINGTON. Last Friday when Commissioner Libby was up here, the weight given by a member of his staff was approximately [deleted]. I knew that was wrong, but did not want to bring it up. I am sure we are getting mixed up, Mr. Chairman, as was so well brought up by you yesterday, in articles I read in the Times and the Post.

Whatever the facts, we ought to be refused them, or be given them straight.

General STARBIRD. I would like to put two things in the record in that regard, sir.

Senator SYMINGTON. Perhaps you do not want to put that weight in the record, because it is pretty highly classified.

Senator HUMPHREY. It will all be scrutinized.

General STARBIRD. Yes. You will have both the secret and unclassified.

General STARBIRD. [deleted]

Senator SYMINGTON. Yes. But I was more interested in it, actually, from the standpoint of what was done. The original bomb was designed for a B–29 bomb bay and weighed [deleted].

General STARBIRD. You are right, sir.

Senator SYMINGTON. I remember seeing it myself in the Bikini tests in 1946.

Since then we have cut down tremendously. That is very important, as these matters are discussed. I heard we had cut it well below [deleted] but that was the figure given us Friday.

Thank you, Mr. Chairman.

Senator HUMPHREY. Yes.

General STARBIRD. We are relatively certain also that in [several years] of research and tests, we can progressively solve the design problems incident to giving us relatively clean weapons in [a wide variety of sizes]. [Deleted.] It is not going to be a question of jumping right away to an [optimum variety of very clean designs]. We have to go forward by steps.

I will come back to that later in connection with your questions on it.

Senator HUMPHREY. What you are saying is that [certain weapons] are more susceptible to what you call clean operation than [others], is that it?

General STARBIRD. Not quite, sir, and I did not make it clear. It is that we [must go forward by steps].

We will have advantage from each series of tests we have, but this does not mean when we come to one particular series we will have clean weapons [for all uses].

Senator HUMPHREY. Yes, sir. I just want to say again that Senator Symington and I worked very closely together and have but one objective. The objective is not to choose up sides, if there are any sides. We hear the arguments made between scientists. Our objective is to get the facts so that whatever we say as Senators or whatever

this subcommittee may say is based upon the best known available evidence.

I do not think we ought to be advocates of one position or another. I think we have one of the most awesome responsibilities to the Congress in an advisory capacity of any group in the Congress. That is why we hold these rather unpublicized, unostentatious meetings. We just listen and study.

As I understand it you are saying that just because you could get a relatively clean bomb [for one application, it does not follow ipso facto that that development goes to all applications]. Is that correct?

General STARBIRD. That is exactly right, sir; exactly right.

ADVANTAGES OF WEAPONS WITH REDUCED FALLOUT

There are sincere individuals, of course, who argue if the next war comes, the Soviets probably won't use clean weapons, and they ask: Why, therefore, should we develop clean weapons? And there is room for argument and discussion.

However, I would like to point out two factors which make the development of clean weapons extremely important, to me at least.

Firstly, if the Soviets ever should resort to a massive attack against their primary target, the United States, we would be well removed from the Soviets and their allies. The detonations would be many, many miles away from them and immediate friends.

The Soviets could use high yield, unclean weapons against the United States without undue fallout hurt to them. I believe this.

The same, of course, is not true, would not be entirely true, of the free world in its counterattack, because there are many targets which lie close to our friends, lie close to our forces overseas. We would like very much, then, to have clean weapons in a variety of yields which we could use against those targets and use against them without hurting our friends and our own forces over there.

Second, as a second factor, our military forces in the military plans of our country are tending to lean more and more heavily on nuclear weapons. There are a variety of reasons for this, but this is a fact. Should a local conflagration or a brush war occur, the most likely spots of occurrence again lie in areas where there are friendly populations, friendly to us and where our own forces are.

For such wars, too, then the tactical [clean] weapons would allow us a great deal more flexibility of use, [deleted].

I must state these are my personal opinions. There are others who do not necessarily share them. However, I believe it sincerely.

DEFENSIVE NUCLEAR WEAPONS

Senator SYMINGTON. Mr. Chairman, I ask a question, if I may.

In addition to all that, if you are going to defend yourself against attacking bombers, you are going to use nuclear weapons in defense, are you not, if they are using nuclear weapons in attack?

General STARBIRD. You will, sir.

Senator SYMINGTON. Therefore, if you do not have clean bombs in defense, you would be putting fallout, radioactivity, all over your own cities in defense, is that not true?

General STARBIRD. That is true. However, [it would be wrong to assume we can have clean weapons for all uses immediately]. [Clean bombs are very difficult to make] [delete].

Senator SYMINGTON. I understand that.

General STARBIRD. [Deleted.]

Senator SYMINGTON. But you want to make them as clean as possible if you are going to use them in defense of your own cities.

General STARBIRD. That is true.

Senator SYMINGTON. In an open hearing recently, Dr. Teller said that unless you used nuclear weapons in defense, you could not have any defense, to the best of his knowledge, against ICBM's or IRBM's. Do you agree with that?

General STARBIRD. I agree with that.

Senator SYMINGTON. Thank you.

TESTS TO PROVE ADVANCED WEAPONS SYSTEMS

General STARBIRD. Now a third purpose of our future testing is that of proving advanced weapons systems and establishing accurately the military and civil effects from such tests.

In this last series, you may remember the Air Force fired the first of an air-to-air rocket. They wanted to find out if that rocket could be delivered and the pilot escape safely. They wanted to prove to the military forces and to others that such a rocket could be used safely over the heads of our own people. So they fired a shot to prove this out.

In the future, I am certain that they will feel, for these more intricate and advanced systems, that there is a necessity to fire such systems to really prove that they will work as a system as a whole, and that the effects will be as forecast by the scientists.

The fourth purpose and the last one, which I shall not discuss in any detail, is that of developing possible peaceful uses of atomic explosions. I think that was adequately covered by Dr. Libby the last time.

EFFECTS OF TEST SUSPENSION ON MISSILE DEVELOPMENT

I would like now, sir, to pass to your second question, if I might: What would be the effect of a weapons ban or suspension on the development of long-range missiles?

Here it is necessary that I talk in terms of specifics rather than general philosophy.

[The answer and discussion was classified almost in entirety. However it was brought out that:

[(*a*) We shall have nuclear warheads for our ballistic missiles when these missiles are available.

[(*b*) The usefulness of a system is a function of accuracy, weight of the missile and yield. With successive further testing weights can be progressively reduced or/and yields increased.

[(*c*) A nuclear test series is scheduled to begin in the Eniwetok Proving Ground in April.]

[Certain of the unclassified discussion follows:]

General STARBIRD. [Now our thinking as to the Soviet position in ballistic missile warheads is that they have designs which they can place on their ballistic missiles.]

Senator HUMPHREY. May I just ask at that point?

General STARBIRD. Yes, sir.

Senator HUMPHREY. Would not the warhead which the Soviet or even we ourselves would be working on, be related in part to the propulsion mechanism and the size that is required there, and the weight, the nature of the fuel, and the directional control devices, and so forth?

General STARBIRD. That is true.

Senator HUMPHREY. In other words, it is entirely probable that the Soviets could have a larger warhead which was not, let us say, as efficient in terms of yield and, therefore, was compensated for in size in order to get the yield and still be able to make it operate well by a better propulsion system.

General STARBIRD. That is absolutely possible, sir.

Senator HUMPHREY. That is what I am trying to get at. They might be less efficient in the warhead department, but much more in terms of thrust and control mechanism and be able to give a terrible punch.

Senator SYMINGTON. That is right.

General STARBIRD. I would like to go now, if I might, to your third question: What would be its effects on the development of nuclear weapons of less radioactive fallout? I have covered this briefly before. However, I would like to repeat and go into more detail so you have a real feel of what this means.

[Here again a detailed and specific discussion took place, classified nearly in its entirety. Unclassified points brought out are the same as those earlier given in answer to question 1. Certain of the related unclassified questions and answers follow.]

General STARBIRD. [I do not believe that the Soviets are experimenting with clean weapons.]

Senator SYMINGTON. In this question of the dirty weapon efforts of which we had knowledge that the Russians have gone into, of course that simply follows their theories of aggression as against defense. How much of the development of the clean bomb, under the laws as they are now constituted, do we give to the British?

General STARBIRD. Nothing, sir, except what is in the papers.

Senator SYMINGTON. Well, how much is that? Do we give them knowledge of our development of a clean bomb?

General STARBIRD. There have been announcements that we were able to make a bomb which had a residual radioactivity approximating 5 percent that of a normal design bomb.

Senator SYMINGTON. Let me repeat my question. The details of how we make a clean bomb and the progress that we are making in a clean bomb, do we give that to, say, the British?

General STARBIRD. We do not, sir. The current law, as you probably know, has a proviso which states that we cannot give anything except size, weight, yield, and this only providing that important information relative to the fabrication and design of the nuclear components would not be thereby transmitted.

Senator SYMINGTON. Thank you.

EFFECT OF TEST SUSPENSION ON DEFENSIVE MEASURES

General STARBIRD. You will remember that your fourth question read: what would be its effect, the effect of a ban or suspension, on defensive measures?

Here I should break the discussion down into two factors: First, defensive measures for the protection of the United States homeland; and, second, defensive measures for the protection of our forces and our people and our friends overseas.

[Here again the discussion was classified almost in entirety. Unclassified points brought out were:

[(*a*) We are deploying now a nuclear air-to-air-rocket for air defense.

[(*b*) We have in stockpile many tactical warheads but their usefulness can be greatly improved with successive testings.

[Certain of the unclassified discussion follows:]

Senator SYMINGTON. Let me just be sure we understand each other, for the record.

The great difficulty in defending yourself against anything that goes 18,000 miles an hour—which is it—or 15,000, we will say between 15,000 and 18,000, is to dope out the lead time aspects of it, because it is hard to hit something moving that fast.

As a result of that, the more yield you have, the greater the chance you have, because the greater the blast and, therefore, the more coverage of the defense unit as it attempts to intercept and destroy the attacking unit. Is that correct?

General STARBIRD. This is exactly right, sir.

Senator SYMINGTON. Thank you.

General STARBIRD. Now deployed with our Army, Navy, and Air Force or in early production for deployment, in other words, something we have gotten past the test stage on and we can now build and are building, are a variety of bombs and warheads for the defense of our forces. These, although eminently useful for defense, are generally larger and heavier than desired.

The systems for firing them, therefore, and for carrying them, have to be larger than is desired under the current dangers of surprise attack.

As an example of this, let me give a few weights of the missile itself for particular systems. [Deleted.]

Your fifth question read: Are nuclear weapons yet ready for defense in local war?

To a large extent I believe I have answered this in the answers to the earlier questions. However, I would like to summarize:

We have the beginnings of tactical weapons for Air Force, Navy, and Army use. We have no clean tactical weapons. [We need several more years of research and testing to perfect and produce certain tactical weapons.]

So this would complete the answers to your specific questions. You indicated this was the type of information you want. Rather than my trying to think of what additional you would like to know, I believe it would be better if you could ask questions of me, and I will try to answer those.

I talk as a technician and not putting forth any proposals at all.

SOVIET NUCLEAR WEAPONS ESTABLISHMENT

Senator GREEN. May I ask a question here.

For a long time the United States public was kept in ignorance of what the Soviets were doing, and the idea spread, intentionally or otherwise, that the Soviets were backward. Then we suddenly woke up to find they have made very advanced scientific researches.

Do you know or can you tell us how far these researches have gone in the atomic energy field, how large an establishment they have, and how long they have been in operation?

General STARBIRD. No, sir; I cannot. I can only tell you this: We detected the first nuclear blast on the part of the Soviets in 1949, I believe it was.

They have increased the frequency with which they set off blasts, [deleted]. We know we have detected a greater frequency of occurrence in recent months than in the early years of their testing.

I have no direct knowledge as to the size of their establishment. [Deleted.]

I can give you my personal opinion as to where they stand. I believe they stand, for nuclear warheads, [deleted] behind us. I am not sure of this. [Deleted.]

This isn't a very good answer.

Senator GREEN. Yes.

General STARBIRD. [Deleted.]

Senator GREEN. Have you any idea now about the extent of their establishment?

General STARBIRD. No, sir; I have not.

Senator GREEN. Or whether it is one plant or a number of plants, located separately?

General STARBIRD. No, sir; I have not.

I surmise there are several, but I, personally, have done no research on it.

CLASSIFICATION OF INFORMATION

Senator GREEN. On what theory was this information which you now give to us classified as not suitable for public discussion?

General STARBIRD. Here, again, I am out of my field, but I will give you the answer that I think is the one, sir. And that is, in the intelligence activities, particularly clandestine, if you can find out what the other man does specifically, then you may be able to put your finger on the source he is using to get it.

Senator GREEN. Yes.

General STARBIRD. And then you destroy that source. I think this is one of the basic reasons that many facts are retained as classified. They are retained in the interest of keeping your source available.

Would you think that was a cause of it, sir?

Senator SYMINGTON. If you are asking me, I associate myself with the remarks the distinguished chairman has made, because I do believe the American people have been kept from information which would have been very, very advantageous for them to have had, and I think one of the reasons we are having this intense discussion about testing now, with a lot of misunderstanding and misinformation going around, is because the American people have been kept from the truth

which, fortunately, now is coming out at least in part as a result of many things, including sputnik.

I have today on my desk a large mail receipt pleading to use my best influence as a representative of these people to stop all nuclear testing. It is unfortunate that some of the information you have been good enough to give us this morning, and some of which could very easily have been publicized without affecting our security, has not been available to the American people before.

Senator HUMPHREY. Please complete your interrogation, Senator Green.

Senator GREEN. Have you any information about the Soviet Union which is still being kept from the American public?

General STARBIRD. About them?

Senator GREEN. About Soviet nuclear investigations and progress.

General STARBIRD. I am certain that information is still retained as classified. Much of what I have given to you as to what we believe their status is, is retained classified.

Senator GREEN. Well, are you given all the information?

General STARBIRD. Am I given all the information?

Senator GREEN. Yes.

General STARBIRD. I have access to—I have never been denied access to anything I have asked for.

Senator GREEN. I do not want you to give any information you do not feel at perfect liberty to give.

General STARBIRD. I am trying to speak frankly.

Senator GREEN. I am speaking from the point of view of the general public.

General STARBIRD. Yes, sir. My hesitation was to answer you frankly. I do not know everything about what the Soviets are doing. However, in my job I am entitled to know it if I feel it is necessary.

TRANSLATION OF SCIENTIFIC LITERATURE

Senator GREEN. We seem to be very loath to communicate what knowledge we do have about what the Soviet Union is doing; and yet, as I understand it from information abroad, the Soviet Union is kept constantly informed of all articles that appear in any magazines in any country which bear on this subject. They are translated into Russian and circulated among their scientists. However, we act according to the opposite principle and suppress information which comes from the Soviet Union, do we not?

General STARBIRD. No, sir.

Senator GREEN. Do we circulate the Russian publications after translating them?

General STARBIRD. There are some in circulation, and here again I am not familiar with what they are. I do know, though, that our laboratories get translations of certain Russian publications that come out.

Senator GREEN. Are they supposed to be comprehensive and include all publications?

General STARBIRD. I think they are getting all that they want, sir, because when they do not get what they want, they usually tell me

they are not getting something, and it is up to me to arrange that they get it.

Senator GREEN. Have you not from the Soviet literature formulated any idea as to the extent of their atomic organization?

General STARBIRD. I have not, sir. You have asked me a question which perhaps I should have formulated, in the sense that it might let me know better where they were going.

However, I am not particularly concerned about what they have, and the mechanics of determining where they are going. There are better people than I who say to me, "We think they are going here in this length of time." I take their conclusions on that.

Senator GREEN. Are their institutions scattered, or are they located in one place?

General STARBIRD. We have direct evidence, sir, as to their test activities, and these, their test activities, have occurred in two separate locations.

Senator GREEN. We do not even know, do we, definitely, what the limits of their laboratories and places for investigation are?

General STARBIRD. No, sir, I do not know.

Senator GREEN. Do we take the same pains which the Soviets seem to be taking to collect all information on this subject, no matter where it appears, what language, and make it available to our American scientists?

General STARBIRD. I think we are, sir. We get information [deleted] where it bears on my particular responsibility, which is to produce a warhead, produce a warhead to go into a Department of Defense missile. [Deleted.]

This I communicate to my laboratories to help the laboratories in knowing what might be of particular interest to the laboratories themselves.

Senator GREEN. Do you think that has been carried as far as it can be?

General STARBIRD. I think that any activity can be carried further by placing more emphasis on it. I cannot say whether the emphasis being placed is adequate or not. [Deleted.]

Senator GREEN. Is that information in part released to the scientific public?

General STARBIRD. In part, sir.

Senator GREEN. Then a certain amount of it is retained. In the beginning, all of it was retained, was it not? We had no information about what progress the Russians had been making until they gave proof of it in the air.

General STARBIRD. I am trying to remember. I think even the first detonation was announced, sir, and I think since that time all significant detonations have been announced. This does not mean that we have announced every detonation.

Senator GREEN. Have the governments had any communication on the subject at all?

General STARBIRD. Of weapons decisions and weapons positions?

Senator GREEN. Yes, sir.

General STARBIRD. Not that I know of, sir.

Senator GREEN. They have not asked for information or given information. Do we keep our information secret, too?

General STARBIRD. We certainly do our best, sir, to do it.

Senator GREEN. Do you think it is successful?

General STARBIRD. I think it is successful. No security system is a hundred percent successful. To me, security is something that tries to buy you time. It tries to keep significant information from getting to the other man so that he cannot make a development which will be useful to him.

I believe that, ultimately, any particular bit of information has a probability of coming out. But I think you gain terrific advantage if you prevent his getting that bit of information, say, 2 or 3 years earlier.

Senator GREEN. Do you think we have been as successful as they have been in keeping it secret?

General STARBIRD. No, sir; I do not think we are quite as successful, but it is because of our basic form of government and the manner in which we control our people.

Senator GREEN. Thank you very much. That is what I wanted to find out.

RELATIVE EFFECT OF TEST SUSPENSION ON UNITED STATES AND U. S. S. R.

Senator HUMPHREY. General; I wanted to say earlier that, every time I listen to the testimony of a man like yourself, and particularly you, sir, I am deeply grateful for the loyal service that you fine technicians and public servants give. It is really, to me, a very inspiring experience. I want to thank you and commend you.

The question that comes to my mind, in light of some of your testimony is whether, if both the United States and the U. S. S. R. suspend nuclear-weapons tests under an adequately inspected agreement, assuming that was possible, would there be a greater disadvantage for one side than the other, would there be a greater advantage for one side than the other, or would both sides be affected about equally?

In light of what you have had to say here this morning as to our present position vis-a-vis the Soviet Union and the needs for the future, what is your answer?

General STARBIRD. I would have to give this as a personal opinion, sir, again.

Senator HUMPHREY. I understand that.

General STARBIRD. If there were an adequate inspection system, and if there were a moratorium, it is difficult for me to see how either would be unduly hurt with respect to the other, providing one other thing is true, and that is, that he does not have in the back of his mind violating the moratorium or reverting to some testing at some future time.

This is a matter that troubles me a great deal, and let me try to explain why.

MAINTENANCE OF A SCIENTIFIC COMMUNITY FOR TESTING

With our form of government, the control we exert on our people, if our people think that we have a moratorium they will probably believe that this is the end of testing, and the end of testing for good, unless there is some direct violation.

The best people we have in this country scientifically are working in our laboratories. Here, again, I believe this: They are people that

we have gotten there because of their basic patriotism. They stayed there because of their patriotism.

However, if they believe their work is no longer necessary, and they cannot make important improvements without testing, then they will tend to go away from these laboratories and go where they can make an important contribution to what is going on.

Now, the same thing could happen to the Soviets, too. But if the Soviets said, "All right; I would like to stop the momentum of the United States research, but we will hold our research by force, hold our people there, and we will intend to test again in 3 years, saying that the moratorium is over and negotiations have broken down," then they could take all sorts of chances in the design, and they could put the resources behind that laboratory, and at the end of 3 years they would have what they had developed, what they had been able to steal from us during the period. They would have the laboratories and institutions in being, and they would be ready to test advanced designs.

Now, this is one thing that troubles me a great deal.

Senator HUMPHREY. It does constitute a problem which I think you have described very well. It is entirely possible that under a moratorium there would be what we could term a letdown in terms of emphasis, both on the part of Congress in appropriating the funds required for laboratories and their modernization and expansion, and, surely, in terms of keeping on the job the skilled scientists and technicians that you have. This is a problem to which I think we must devote a great deal of attention.

I ask these questions because I think when we talk about a test ban, we have to probe all of its implications.

RELATIVE EFFECT OF TEST SUSPENSION ON U. S. AND U. S. S. R.

Setting aside the factor that you have just mentioned, the possible building up of Soviet technology during this moratorium period in preparation for a new series of testing at the end of the moratorium, would you feel that a ban on testing at the present time, let us say this year, with effective inspection, would put us in a disadvantageous position in regard to the Soviet Union?

General STARBIRD. I think it probably would if it were right now. I think it is questionable as to whether or not you could pick up the decided disadvantage toward one of the two sides if it were a year from now.

Senator HUMPHREY. I said within this year.

General STARBIRD. I, thinking further, think I ought to point out what the factors are, and then, thinking as I go along, perhaps, answer.

[With respect to certain weapons, we would lose in terms of development.]

He, the Soviets, would lose the same thing.

Assuming we are in a position where our two ballistic missile forces can each deliver a high-yield warhead, then this means, if he is [adequate] in missiles he has at that time an ability to deliver a devastating attack.

This, then, thinking this through a little more, would lead me to the conclusion that perhaps there is some advantage to him in cutting

off tests—relative advantage to him. It is a very complex matter, but this is as I would develop it, sir.

Senator HUMPHREY. I understood you to say you thought we were [deleted] ahead in atomic weaponry.

General STARBIRD. Yes, sir, [deleted].

Senator HUMPHREY. If the testing were stopped this year, and it was verified that the moratorium were abided by, in case there was a violation, then of course the agreement would be off, if we are ahead in atomic weaponry [deleted] would not the Soviet Union be equally restrained in terms of catching up with our weapon development?

General STARBIRD. We hope he will always be—let us assume tests do not become stopped—we hope he will always be [deleted] behind us; that we will continue this aggressive research and development program we have and stay [deleted] ahead of him.

Senator HUMPHREY. Yes.

General STARBIRD. Now, it is a question of opinion as to whether he will be able to catch up any closer than he is right now. I do not know. But I really, in changing my original answer to you where I said I thought the advantage or disadvantage was about equal, I really think the balance is that he will profit more through a suspension than we.

Senator HUMPHREY. Why?

EFFECT OF TEST SUSPENSION ON MISSILE DEFENSE

General STARBIRD. Because it rules out certain clean devices [and—] [deleted].

Senator HUMPHREY. The delivery system, though, would not be ruled out in terms of the moratorium. We could still be working on the delivery systems. What we are really talking about is warheads. The guidance system, the delivery systems, the thrust and propulsion, research on all of this could continue. The effect of a test ban agreement would be upon the warhead themselves.

I am not trying to argue the case. I am just trying to pin it down. The Soviet likewise would be limited on small weapons, would it not?

General STARBIRD. It would be, sir.

Senator HUMPHREY. And intermediate weapons.

General STARBIRD. Similarly limited, and on clean weapons. Maybe I can define my statement a little more. [Deleted.]

Senator HUMPHREY. I can see that, but you are setting up a set of assumptions which would not necessarily be valid. There is no reason to assume, unless it is just sheer dereliction or incompetence, on our part, that the Soviet would supersede us in the next 2 or 3 years in a delivery system.

I am presuming that our industrial capacity and our scientific know-how in terms of perfecting a delivery system is as good as that of the Soviet. Since those are not effected by a test ban agreement, what we are really talking about is not delivery systems, not propulsion, but the matter of explosions.

The question boils down as to whether or not we have more to lose than the Soviet Union, or whether we have more to gain than the Soviet Union, in light of at least the [deleted] alleged advance that

we have in atomic science insofar as weaponry is concerned. Do we have more to lose or to gain by a cutoff on tests—not of propulsion systems, not of delivery systems or guidance systems, but strictly of warheads?

General STARBIRD. Well, I think I would have to change my original answer to you and say that I believe we probably would have more to lose than do the Soviets.

Senator HUMPHREY. I would like to know why. At this stage, I cannot quite see that point. I want to know why you think we would have more to lose.

EFFECT OF TEST SUSPENSION ON UNITED STATES

General STARBIRD. I am thinking of things that we are working on and, I believe I explained earlier, I think are really important systems, the clean ones, [and others].

Senator HUMPHREY. I can see where, if we got weapons with greatly reduced fallout that would be excellent. It would surely put us in a much more enviable position. But apparently the Soviets do not have those, either.

General STARBIRD. No, sir. But they have a different psychology than we have. We are always the one who plans on countering, not the one who plans on attacking.

If he has adequate means to attack, and we have no defense against it, whether it be a local war or a big war, or if our counter is limited in some way because we cannot use it as flexibly as we want, then we may very well be at a disadvantage although we have more different systems, more efficient systems, than he.

We just do not have time to bring those into play. The war may be over long before we could effectively use these many different systems that we have.

Therefore, I think in terms of: Would we lose something that is critical to our defense by a moratorium, and would he lose something that is critical to his plan of attack?

With respect to defense, I see ourselves losing [deleted], and I see ourselves losing clean weapons.

Now I am not in his shoes and probably he can see losses that I cannot see, to him. But the most important thing to him, I would think, would be ballistic missile warheads, and I am assuming that he knows how to make these now, and it merely becomes a question of priority and building to let him develop what would be a capable attacking force here.

I assume also—I mean it is true he has interior lines. He can get along probably with a lesser number of weapons and perhaps even a lesser number of systems than we. This is not too clear an answer, because I think there are so many factors involved that I ought to go away and think for 3 weeks and then come back and answer what you have given us as a simple and direct question.

Senator HUMPHREY. I think this is exactly what everyone in this crucial role, everyone who holds a responsible and crucial role in this, must do.

I think it is reckless to talk about agreements on banning tests or even a cutoff of nuclear materials unless we are positive that we

know what we are talking about and know what its implications are. The implications are deep and varied.

I am frank to tell you I am just probing out loud. I think every one of us here has a tremendous responsibility not to mislead the public or to mislead ourselves, and I think as we ponder this we might want to come back to it again and view it in the total perspective.

The President and the National Security Council must weigh many things. There are foreign-policy implications, there are relations with our allies, and all kinds of matters involved.

You speak essentially from the weaponry point of view, and that may be counterbalanced by some other consideration with the President and the Secretary of State have in mind.

I have an additional question. I had others, too, but we want to get to our next witness, so we do not want to take too much time.

NEED OF SOVIET UNION FOR DEFENSIVE WEAPONS

[Would not the U. S. S. R. be reluctant to attack the United States unless they had a weapon which had so little radioactive fallout that they could use it over their own territory for defense?]

General STARBIRD. I think not, sir. I think not, because if they attack—and again I am putting myself in their shoes—if they attack, I think they must assume their attack is going to be successful in destroying a large portion of our counterattack before it gets to the Soviets. [Deleted.]

Nuclear weapons are a large step forward in working against a bomber, defending against a bomber. They are not the only means of defending against a bomber, though. You can do it with conventional explosives—not as well, but you can do it if you have enough conventional explosives and you can deliver them properly.

Now as Senator Symington has brought out, I do not think this is true with respect to countermissiles. I think there you must have a nuclear warhead. But for the present, to answer your question, I think it does not follow that they must have available clean defensive weapons before they can strike.

Senator HUMPHREY. Senator Symington, you were interrupted here awhile ago.

EFFECT OF TEST SUSPENSION ON NATIONAL SECURITY

Senator SYMINGTON. Thank you, Mr. Chairman.

I have been listening to this discussion with a great deal of interest, and would like to ask a couple of questions which have to do with some of the questions already asked.

What you are really saying is that if we suspend testing and, therefore, cannot obtain a clean bomb, which would be essential against [deleted] we might be jeopardizing our security, might we not?

General STARBIRD. We might be jeopardizing it. There is one thing I would like to correct. I gave the impression that our early [deleted] will be clean. This is incorrect. It is going to be a long time before we get that.

Senator SYMINGTON. I understand.

Now we talked about who would profit more or less by a suspension of testing. I remember back in 1946, Air Marshal Tedder said there was one military asset the Russians had we could never hope to equal, and that was the asset of their complete disregard of human life.

So our desire to have a clean bomb is probably based more on our philosophy of government and what life is all about, than theirs, wouldn't you say?

General STARBIRD. I would agree with that.

Senator SYMINGTON. When you got into this question of who would or would not benefit most by suspension, you did not bring in, or if you did I was not listening properly, the question of Soviet cheating.

Senator HUMPHREY. I was assuming an effective inspection.

General STARBIRD. I did not bring that in. It is a very great factor.

Senator SYMINGTON. In other words, the premise of your remarks—and I am glad to have the Chair remind me—the premise of your remarks had to do with an effective inspection system, did it not?

General STARBIRD. Yes, sir.

Senator SYMINGTON. I now refer back to something which Senator Green mentioned, about this giving of information to the people.

RATE OF SOVIET PROGRESS

As I remember it, we first discovered the firing of their atomic bomb in September of 1949. That was a little over 4 years after we first fired an atomic bomb.

General STARBIRD. Yes.

Senator SYMINGTON. We let go a hydrogen bomb in late 1952. They fired theirs about August 1953, is that right?

General STARBIRD. I think that is right.

Senator SYMINGTON. So they closed the gap on us, ostensibly, from the standpoint of what the American people knew, from over 4 years to less than 1 year; is that correct?

General STARBIRD. From what the public knew?

Senator SYMINGTON. From what the public knew.

General STARBIRD. I believe that is right, sir.

Senator SYMINGTON. Right.

RELATIVE POSITION OF UNITED STATES AND SOVIET UNION

All I am saying is, when Senator Green brought this matter up today, he brought it up from the standpoint that we have been, in effect, fooled. The sputnik was a great shock to the American people, because it blasted the basis of our defense planning, namely, that we could afford to pass over quantitative superiority to the Soviets because we had qualitative supremacy.

We now know that is not true.

When you say that you believe we are ahead of the Soviets in this field, therefore, I question that.

When Defense came up for money for the satellite last August, they said that "We know we are ahead in satellites, and we want this money"—that was only 6 months ago—"because we want to be sure to stay ahead."

Thank you, Mr. Chairman.

Senator HUMPHREY. Thank you.

General, you go ahead if you wish to make a comment.

General STARBIRD. [Deleted.]

Senator HUMPHREY. Thank you very much, General Starbird. We are very grateful for your testimony.

I want to say that tomorrow in executive session we are going to have Dr. Scoville, who is the Assistant Director for Scientific Intelligence for CIA, as a witness. He will discuss the detection of Soviet tests.

INTRODUCTION OF DR. SPOFFORD ENGLISH

We will now hear from Dr. Spofford English, who is the Deputy Director of the Division of Research of the Atomic Energy Commission. Dr. English, I understand you are going to concentrate your attention on the cutoff of production of fissionable material for weapons purposes, and the possible effectiveness of inspecting such a cutoff. Is that correct?

STATEMENT OF DR. SPOFFORD G. ENGLISH, ACTING DEPUTY DIRECTOR OF RESEARCH, ATOMIC ENERGY COMMISSION

Dr. ENGLISH. That is correct.

Senator HUMPHREY. A cutoff of production of fissionable materials for weapons purposes is what the Preesident refers to as the heart of our disarmament package, I believe. Is this not to what he has alluded?

Dr. ENGLISH. I believe that is correct, sir.

Senator HUMPHREY. Would you proceed.

Dr. ENGLISH. Mr. Chairman and members of the committee, it is a pleasure to appear before you today to discuss certain aspects of disarmament relating to the technical problems involved in inspection and control of atomic energy production facilities. I am Spofford G. English, Acting Deputy Director of the Division of Research of the Atomic Energy Commission.

In your letter of March 6 inviting me to testify, you directed my attention to the second of four subjects on which this committee is currently holding hearings. This topic is "The Relationship of Nuclear Weapons Tests and Production to National Security and the Control of Armaments."

More specifically, I understand that you would like me to discuss questions relating to the technical feasibility of inspection of fissionable material production plants under conditions of a disarmament agreement which includes an agreement for the cutoff of production for weapons purposes.

I will discuss the technical feasibility of the inspection of fissionable material production plants, the nature and extensiveness of such a system, the personnel requirements, including types of personnel needed, and the performance which such a system might be expected to give in terms of probability of suspecting an attempted diversion of materials.

DEFINITION OF THE CUTOFF PROPOSAL

In this discussion I will assume that the cutoff of production for weapons purposes means a continuation of production, but with the

output of all fissionable material accounted for and safeguarded in order to ascertain that it is not used in weapons.

Senator HUMPHREY. That has been the interpretation that Mr. Stassen and others gave to us before.

Mr. ENGLISH. I would like to remark that this condition of continuing production is a necessary one, for in the case of power reactors for peaceful purposes, these reactors can, of course, produce fissionable material as well as useful power. The condition would also apply to uranium isotope separation plants required to produce fuel for power reactors.

I believe this covers the questions on which your letter indicated you wished my views, with the exception of the question as to the effects of a cutoff of production for weapons purposes on our weapons program and our security. If it is agreeable with you, I would prefer to leave this topic for General Starbird, who is far more qualified than I to discuss this matter, and who has in fact touched on this matter in his testimony just given.

NORMAL ACCOUNTABILITY IN PRODUCTION PLANTS

First let me say that inspection and control of a facility for producing, or using, fissionable or source material—by source material I mean natural uranium or thorium—is a matter of continuous accountability and physical security of those materials at critical points within the facility.

By accountability, I mean a knowledge of the location and amount of all such materials; and by physical security I mean the provision of suitable means, including guards, to make unauthorized physical removal of material extremely difficult.

Accurate knowledge of the amounts and location of these materials in a complex plant is, in most instances, a difficult matter. Such knowledge depends on making continuous and detailed physical and chemical measurements and analyses. The result of obtaining such measurements, however, is the ability to determine what is known as a "material balance" across the plant.

This is somewhat like the balance one makes at intervals in one's bank account—that is, the amount on hand at the beginning of an interval of time plus the deposits (deliveries to the plant plus production within the plant), less withdrawals (or shipment from the plant) should give a new balance at the end of the interval equal to the amount actually found to be present.

Obviously, this analogy is grossly oversimplified because within the facility making or handling fissionable material, the material will be in dozens of chemical and physical forms. It will be in solutions, flowing through pipes, stored in tanks or undergoing reactions which change its form. Much of it will, in general, be inaccessible because it is highly radioactive or is in process equipment which cannot be entered.

MEASUREMENT OF UNAVOIDABLE LOSSES

In addition, of course, all processing methods are subject to unavoidable losses, and while most of these can be measured, the measurements cannot be made with absolute precision. Another major flaw in the "bank balance" analogy is that one does not normally attempt in,

for example, determining the amount of money represented by a stack of 50-cent silver coins, to measure the silver content. One simply counts the pieces.

Thus, the probability is very high, in this simple case, that two people counting the same stack of coins will agree completely on the number. A machine, of course, can perform this function with extremely high precision and reliability. This is not true in the case of a plant where the amount, in terms of weight, of a material is being sought. Here we normally remove a sample from a large volume, and we must be sure it is representative of the large volume, and perform a chemical analysis on it.

In general, it is a fact that two different and equally competent analysts, both honest persons, in making the same analyses will obtain results which differ slightly—in fact the same analyst in making a series of supposedly identical analyses on the same solution, will get slightly different results. It is the accumulation of uncertainties of this sort from the hundreds of measurements needed to obtain a material balance which leads to an inability to strike a balance which is perfect.

There are, of course, mathematical and statistical tests which can be applied to uncertainties in order to see whether the uncertainties are within the limits of fluctuation normally to be expected, or whether they are outside these limits and therefore are cause for further investigation, on the possibility that they indicate an unknown source of loss or diversion. It is this sort of signal which the inspection system will generate from accountability data, and which will make one suspect that a diversion is being attempted.

The physical security counterpart in the system—and they go hand in hand—would, of course, be for the purpose of attempting to detect the diversion act itself, whether carried out by persons, or by carefully installed and concealed mechanical means. It would have the added feature of providing a strong deterrent effect against attempts to divert.

IMPROBABILITY OF DEVISING COMPLETELY FOOLPROOF SYSTEM

I should like to state at this point that one occasionally reads about the possibility of devising foolproof methods or techniques which would make diversion absolutely impossible. We know of no such system. Nor do we believe that a 100-percent perfect system is likely to be developed. By its nature the problem is simply too complex and varied to lend itself to this kind of a solution.

This is not to say that there are not dozens of ingenious methods and devices which could be employed in specific cases, and which would be employed certainly, to make the probability of undetected diversion quite low. Essentially, the system involves careful measurement, accurate and ingenious instrumentation, and much hard work.

DEGREE OF EFFECTIVENESS NECESSARY

The problem may be stated as that of devising a system of accountability and physical security such that the probability of detecting an attempted diversion——

Senator GREEN. Will you repeat that?

Dr. ENGLISH. Yes. The problem, and I think this is quite important, the problem may be stated as that of devising a system of accountability and physical security such that the probability of detecting an attempted diversion is so high that the attempt to divert is judged to be not worth the risk incurred.

Senator HUMPHREY. In other words, to get a system that is so close to being accurate——

Dr. ENGLISH. That you remove——

Senator HUMPHREY. That if you violate it, the odds are so much against you that you will be caught, that it would be better to conform.

Dr. ENGLISH. Right.

This, I think, poses the problem that one must address oneself to in attempting to see what one must do to make this risk high.

I would like to state at the outset that it is technically feasible to devise a system of safeguards designed to detect attempted diversion of material, but we need now to discuss the performance of these systems in order to arrive at a basis for judging whether they will provide assurance against diversion which is great enough to make them acceptable.

As to being technically feasible, this is certainly the case, but we need to evaluate it further.

OPERATIONS OF NUCLEAR FACILITIES

In order to describe in somewhat more detail how the system would work, I should like to take as an example the case of a large production installation, such as Hanford, devoted to the manufacture of plutonium. This installation would be expected to consist of fuel fabrication facilities, a number of large nuclear reactors, storage and cooling basins for material discharged from the reactors, chemical processing facilities for extracting and purifying the plutonium and unreacted uranium, and waste disposal facilities.

In this complex, the fuel fabrication facilities would prepare the uranium fuel for insertion into the reactor. It involves such operations as the rolling and machining of uranium metal, the "canning" of the metal in aluminum jackets. The reactors themselves might be of the graphite moderated, water-cooled type in which the uranium is inserted in long channels through a roughly cubical array of graphite, with cooling water flowing in the channels around the uranium fuel.

In the reactor, fission of uranium 235 takes place, neutrons are released in the fission process and convert part of the uranium 238, which is intimately mixed in the fuel, to plutonium. The chemical processing plant is designed to take the irradiated fuel from the reactor and by chemical means, after dissolving, to separate the plutonium in pure, concentrated form.

The chemical plant also recovers for reuse the unreacted uranium and separates the highly radioactive fission products in a form in which they can be stored, or put to other uses.

Normal plant operating procedures for a complex such as this involves, of course, material accountability procedures. This is abso-

lutely necessary in order to properly and efficiently operate the plant. You must know where the material goes.

Senator HUMPHREY. Right now.

Dr. ENGLISH. Right now, even in the absence of an inspection system.

Senator HUMPHREY. I recall several years ago there was a press report about some material being lost.

Dr. ENGLISH. Yes.

Senator HUMPHREY. Or stolen. It just dawned on me that that had happened.

Dr. ENGLISH. One has an accountability system in any event, because you need to control the plant. Of course, in addition the material has a high monetary value, and so you do it for several reasons. But you must have this information even just to be able to operate the plant efficiently. You must know where the material goes.

INSPECTION SYSTEM UNDER A CUTOFF AGREEMENT

The inspection system about which I am here talking would be superimposed upon the plant operations and would make use of normally collected plant data. The system would, in addition, provide for the independent taking of such data as would enable the inspection organization to arrive at an independent judgment on accountability for materials.

The inspection force would take samples for analysis, duplicate samples, if you will, in the fuel fabrication operations and in the recovery operations carried out on the scrap for machining. It would independently weigh the uranium fuel pieces and maintain its own records of the history, data on, and destination of the fuel. In addition, inspectors would accompany each interplant shipment.

In the reactor area the inspectors would observe and check each reactor loading and unloading operation, and would, with their own instrumentation, measure the power level of the reactors, as an index to production. They would, at intervals, both absolutely calibrate, and intercalibrate their own instruments with the plant equipment.

The reactors would be thoroughly inspected at intervals in order to be sure that no construction had taken place, between inspections, which would permit either diversion of materials or false readings of instruments.

Diversion from the reactor itself is not especially easy since the fuel is usually in discrete pieces, and is therefore easier to account for. In addition, it is highly radioactive, making it both hazardous to make off with and easier to detect.

One of the main purposes, therefore, for close and careful monitoring of the reactor is to provide data from which to calculate the amount of plutonium formed, since this amount must be accounted for later in the chemical processing operations.

Senator HUMPHREY. And those records are kept regularly in all atomic installations; is that right?

Dr. ENGLISH. Absolutely.

Senator HUMPHREY. I have been told that those records must be kept in order to know that the plant is operating on a scientifically valid basis.

Dr. ENGLISH. Absolutely. This is entirely correct, sir.

Senator HUMPHREY. In fact, there is a safety factor involved in all of this; is there not?

Dr. ENGLISH. Right. You must know the power levels because this is related to heat removal problems, and the cooling of the reactor. And, of course, serious things can happen if reactors are not controlled properly. All of these things are important.

We are talking now about making use of these data by the inspection team independently taking some of its own to be sure they themselves can stand up and say, "We know."

ANALOGY WITH INSPECTION OF VACCINE PRODUCTION

Senator HUMPHREY. Yes. There is a similarity here with the inspection of Salk vaccine. A plant producing vaccine has its own inspection system all the time in reference to the vaccine it is producing, nevertheless the Government comes in with the United States Public Health Service and also makes an inspection. There was a big argument a few years ago when this whole Salk vaccine situation was in such a turmoil, about how many inspections were to be made, thus there was a superimposed inspection system upon a regular plant inspection system. Needless to say, inspection for nuclear materials would be more intricate than for the production of a vaccine. Nevertheless both have to be very accurate.

Dr. ENGLISH. Right.

Senator HUMPHREY. Both have to be accurate.

Dr. ENGLISH. Your analogy is very good, sir.

INSPECTION OF CHEMICAL SEPARATION PLANT

The chemical separation plant, which is the succeeding operation after the reactor, provides probably the most difficult operation to control. Here the material is in solution. The composition, concentration, and volume of the solution change at many points in the plant. The material to be controlled and accounted for is flowing in pipes, into and out of tanks, and through reaction vessels.

The plant itself is a large and complicated maze of valves, pumps, pipes, tanks, sample lines, steam and chemical lines, and instrument lines. Tons of uranium and hundreds of grams of plutonium may flow through the plant each day.

The problems here, however, are dealt with in the same fashion—detailed analyses at critical points, prompt and continuous evaluation of a data and physical security surveillance to make sure that material is not removed and that equipment is not secretly modified so that product can be diverted.

The most sensitive part of the plant is, of course, the points at which plutonium is isolated in concentrated form and stored. At this point the hazardous radioactivity of the fission products has been removed and a small volume represents a much larger amount of dangerous material.

To describe quantitatively the performance of a safeguard system is difficult.

Senator HUMPHREY. May I go back for a moment. At the point at which the plutonium is isolated and the radioactive fissionable mate-

rial has been removed, and, as you say, only a small volume—do you mean there the plutonium?

Dr. ENGLISH. Yes.

Senator HUMPHREY. Represents a much larger amount of material. Do you think that at that point it would be possible to have effective guard and inspection?

Dr. ENGLISH. Yes, I do, and I think at this critical point what this would entail would be, of course, 24-hour-a-day actual on-the-spot observation by one or more inspectors. They would simply keep their eyes on it at all times. When it was stored it would be locked in vaults, perhaps with a guard inside or outside, but in such a way that it was foolproof with respect to someone making off with the material undetected.

Senator HUMPHREY. Would you have a check-in like a weight check-in and test as to the qualities?

Dr. ENGLISH. Right.

SenatorHUMPHREY. You would have a checkout on the same sort of basis, and also observation while within?

Dr. ENGLISH. Right. This is where you would try to devise the most ingenious instrumentation such as locks on doors, and interlocks, and devices like that. But at this particular point, once an analysis was made so you knew how much was in a given sample flash, for example, then physical security would be required to observe the material at all times.

Senator HUMPHREY. Yes.

Go ahead, sir.

POTENTIAL EFFECTIVENESS OF INSPECTION SYSTEM

Dr. ENGLISH. To try to put some quantitative significance as to what the method will do is most difficult.

Perhaps the most satisfactory method of presenting the results is to state the probability that the inspection force will suspect a diversion within a stated period of time if the diversion is equal to a certain percentage of throughput. This is a method of expressing performance.

The case we have just been discussing, namely, a complex consisting of a number of large plutonium production reactors and the fuel fabrication and chemical processing plants necessary to feed material to, and recover material from, the reactors would require a team of approximately 500 men in order to achieve a capability, within a 12-month period, of suspecting a diversion 9 times out of 10 if that diversion was equal to 1 percent of the throughput. Stated in quite equal, but in different terms, this estimate means a capability of suspecting, again within a 12-month period, a diversion 99 times out of 100 if the diversion was as much as 2.5 percent of the throughput, and only 1 chance in 10 if the diversion was 0.1 percent of the throughput.

For these figures, I should like to emphasize two points. First, these numbers are estimates since they are based not only on accountability measurements, concerning which we do have a quite firm basis for estimate, but also on the effectiveness of "observation of actions" by the inspecting personnel. This latter becomes a much more subjective matter.

Senator HUMPHREY. At that point, Doctor, does it not also become a matter of concern that we do have an adequate number of duly qualified, trained experts in this area of inspection?

Dr. ENGLISH. It does. Later I will try to talk to the personnel figures and try to give you some feeling as to our opinions, at least, of the kind of personnel, and then we can try to discuss whether they are available and how many will be needed.

Senator HUMPHREY. Thank you, sir. Proceed.

IMPORTANCE OF TIME INTERVAL BETWEEN INSPECTION

Dr. ENGLISH. The second point I would like to make with respect to these numbers is that the statement of the time interval is an important factor.

Due to the fact that this complex has a large inventory of material—that is, a large amount of material—which is in the complex itself compared to what is coming out of it every day, due to the fact that inadvertent maloperation of some part of the plant may cause momentary holdups of material, and due to the difficulty of computing the amount of plutonium in a given batch of material discharged from a reactor—the point here is, you can calculate, for a freshly loaded reactor, how much is made in the whole reactor in a given period, but you do not dump it all at once, but by pieces, and there is difficulty in assigning to a given batch, if you will, how much material is in that one. Of course, these differences tend to become smaller over a period of time. For these reasons, the system of safeguards will perform with more certainty over a long interval of time than over a shorter one.

For the figures given previously, the diversions would have to be greater for the probability of suspecting diversion to be the same as stated in a period of 1 month, say, instead of 1 year.

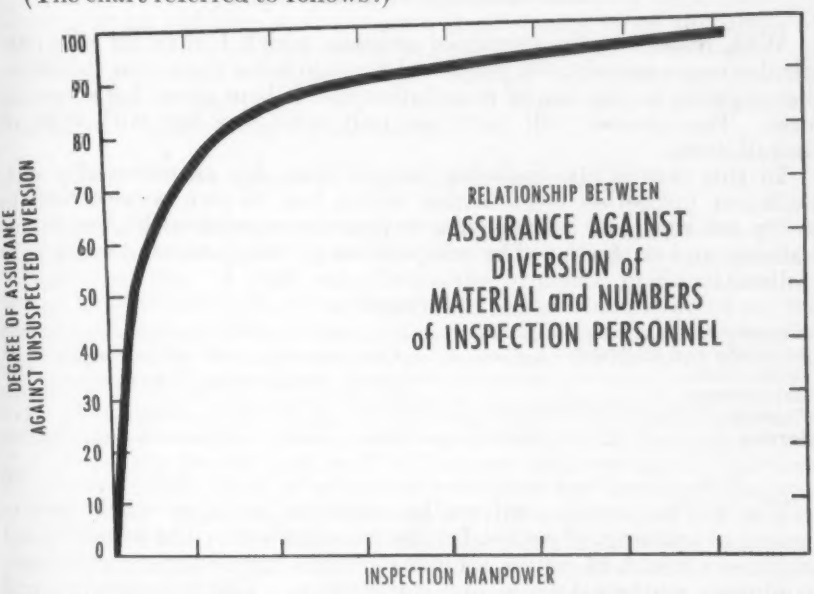
And, conversely, if the period of time over which you are observing is longer than a year, then the limits within which diversion without being suspected could take place, are lower.

Senator HUMPHREY. I understand.

NUMBER OF INSPECTORS NECESSARY

Dr. ENGLISH. I would like to show you, if I may, at this point a chart which does not really attempt to be quantitative, but I think it illustrates the idea.

(The chart referred to follows:)



Dr. ENGLISH. Here we have plotted degree of assurance against unsuspected diversion versus manpower required. The important feature of this graph is that it clearly is not a straight line function. If it in fact was a straight line function starting at zero for zero assurance and intersecting the top line at 100 percent you would select the indicated number of people and say this is what you need to get 100 percent assurance.

The problem simply is not of this type. This shows, as you begin to add people, that you achieve very rapidly, climb very rapidly, with respect to ability to know something. Once you reach a point on the more horizontal part of the curve, adding an increment of men buys you relatively less, so there is an optimum point.

You could, of course, continue to add men until you had one inspector looking at each person in the plant. This obviously does not make much sense, because what you buy with it in terms of increased assurance is simply not worth the added cost.

It also shows, though, that in reducing personnel, once you reach a fairly critical point where the curve begins to become more vertical, if you take off even a few men you lose very rapidly in assurance. The numbers I am giving are based on conclusions of many studies that this is the sort of system which one would have to have to do this sort of a job.

It would be costly to push it up much more, but you would lose rapidly in effectiveness if you drop it down.

Senator HUMPHREY. Yes, sir. You get to a point of no return here.

Dr. ENGLISH. That is right.

Senator HUMPHREY. You have to have a certain optimum number in order to get optimum results.

Dr. ENGLISH. Correct.

COMPOSITION OF INSPECTION TEAM

With respect to the personnel estimate which I gave for this particular case—namely, 500 people—I want to make clear that this number depends on the size of installation and is here given for a specific case. The number will vary not only with size but with type of installation.

In this case it also includes the provision for an essentially self-sufficient inspection organization which has its own service staff to carry out repair of instruments, to provide transportation, communications, and so forth. The composition of this projected team is as follows:

Personnel

Inspectors	120
Scientists and engineers	54
Technicians	76
Management	50
Clerical	50
Service	150
Total	500

The 120 inspectors need not be scientists, but they would receive technical training, of course, for their assignment. The scientists and engineers would, of course, include chemists, metallurgists, physicists, engineers, mathematicians, and statisticians. The technicians would be trained to make routine analyses and measurements. The management would certainly require men who have experience and training in the atomic-energy field, although not all of them would need to be scientists or engineers.

So, in summary, perhaps on the order of 75 of these 500 people would be highly qualified scientists and engineers, and I emphasize again that this is for an essentially self-sufficient organization.

Senator HUMPHREY. The rest of them would be susceptible of reasonably short training periods to prepare them for their assignments.

Dr. ENGLISH. Yes. The technicians, I think, would require somewhat more training, because they would have to be trained in detailed and sometimes complicated procedures, but they would not need to be people with degrees in science.

Senator HUMPHREY. What would that figure of 500 cover?

Dr. ENGLISH. This 500 figure is projected for a large plutonium production facility, consisting of a number of large reactors, a sufficient number of chemical plants to serve the reactors, and fuel fabrications areas—in other words, the case that I have just been describing. This is for an entire complex such as, for example, Hanford.

Senator HUMPHREY. Yes, sir.

Dr. ENGLISH. Since we have been talking about a single, though large, installation, it is evident that a sizable total number of people would be needed for this function under a disarmament agreement.

I would like to emphasize, however, that the size of the inspection force here discussed for a particular case is but a relatively small fraction of the normal force required to manage, operate, and maintain the installation. Recruitment of these personnel would present a real problem, but not an impossible one, in my opinion.

In the case of a single power reactor, for example, the number required to be resident at the reactor itself would be of the order of 10 to 15, exclusive of supporting organization staff. The number of resident personnel required for a chemical plant serving perhaps several power reactors would be 2 to 3 times this number, again exclusive of supporting organization.

INSPECTION OF GASEOUS DIFFUSION PLANT

I should like now to say a few words about the problems of inspection and control of a gaseous diffusion plant for the production of uranium 235. I shall not discuss the problems in detail, but attempt to give the results to be expected in this case and to point out the nature of the problem. The gaseous diffusion production plant is characterized by its large size, large in-process inventory of uranium, and quite large power consumption.

In this plant uranium is isotopically separated by passing a gas containing uranium, usually uranium hexafluoride, through porous barriers. The products of such a plant are uranium highly enriched in uranium 235, which is of primary concern for the inspection system, and the "tails," or uranium depleted in uranium 235. The tails must also be controlled and accounted for since the isotopic composition of uranium in the tails is an index to production of enriched uranium 235 and also, of course, because plutonium can be made from this material. It is known as a fertile material.

Here again, the problem is one of detailed accountability for materials, in this case complicated by the miles of process pipes and vessels through which uranium hexafluoride, in varying degrees of enrichment, is flowing. This means that physical security, or direct observation, of the plant is of relatively greater importance. There is no radiation hazard associated with this operation.

The problem of accountability in a gaseous diffusion plant is also complicated by the fact that the in-process inventory of material in the plant is difficult to estimate. This difficulty arises from the fact that some uranium deposits in a thin film, or surface layer, on the barrier and pipes, and the total surface area of equipment in a large gaseous diffusion plant is enormous. The buildup of material varies with time and with the design of a specific piece of equipment, and can only be accurately measured at the time the equipment is removed, cleaned, and replaced with new parts, which is infrequent.

Under conditions of complete access to all parts of the plant, and with the cooperation of plant management which would be necessary in order to run the plant in such a way as to facilitate the determination of the inventory deposited on process equipment, it is estimated that with a 370-man inspection force, the probability would be high for suspecting, within a year, diversions greater than approximately one-half of 1 percent of throughput. The same comments made earlier with respect to the time factor apply here also.

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PERSONNEL REQUIREMENTS FOR GASEOUS DIFFUSION PLANTS

The personnel requirements for inspecting a large gaseous diffusion plant may be summarized as follows:

Administrative staff	5
Engineering and special functions	12
Accounting and computing	18
Material handling	35
(Material handling involves transfers of material from one point in the plant to another.)	
Analytical laboratory	45
Supporting activities	30
Physical security	225
Total	370

Of this total, approximately 66 persons would need to be scientists or professional persons. Again, this total represents a small fraction of the organization required to operated and maintain the plant.

Senator SYMINGTON. You say a very small fraction. What percent would it be, 370 of what?

Dr. ENGLISH. In this case it is approximately 8 percent. In the case I gave previously, around 5 percent, in this range somewhere.

I should also qualify it by saying that this is a percentage taken of the total number of people in all categories required at the plant—management, clerical help, secretaries, service, guards, and everything. It is relative to the total personnel of the plant that this percentage is taken.

One other large category of cases exists; namely, the power-reactor complexes, which will be expected to increase in number as time goes on and as the power program increases, and whose major function is to produce energy in useful form.

Each of these will also have the capability, to varying degrees, of producing fissionable material—either plutonium or uranium 233. The types of these installations and their chemical plants may be expected to vary widely, but the problems as outlined for the case of production reactors are very similar and would be attacked in the same manner. Here also, complete access to all parts of the operation is important.

DETECTION OF NUCLEAR FACILITIES

One other aspect of the disarmament problem relating to atomic energy plants must be stressed. This is the problem of making certain that all existing plants are known and, therefore, subject to inspection.

Senator HUMPHREY. Do you think that is a serious problem?

Dr. ENGLISH. Yes, I do, sir. Not in this country, because I think that probably even the Russians believe that there are no hidden plants for atomic energy production in this country, but it could be quite a serious problem because if one is denied access to sizable areas of a territory, you simply could not determine what is going on.

Senator HUMPHREY. Therefore for an agreement on a production cutoff, there would have to be relatively free movement and exploration for discovery of plant facilities; is that correct?

Dr. ENGLISH. I believe so very strongly; yes, sir.

Senator HUMPHREY. Go right ahead, sir. I will come back to this.

Dr. ENGLISH. This is the problem of making certain that all existing plants are known and, therefore, subject to inspection. It is pos-

sible to imagine attempts to conceal the existence of plants. Such an attempt could be successful if access to large territories of a country is not permitted.

Atomic energy plants are characterized by the existence of radioactivity in the case of reactors and their associated facilities, and consumption of large amounts of power in the case of isotope separation plants, but it could be quite difficult to definitely establish the identity of a plant, particularly the latter, from a distance. For this reason it is essential that a group of inspectors be assigned the responsibility and rights, of inspecting for the possible existence of clandestine plants.

COMPLETE ACCESS TO PLANTS ESSENTIAL

Less extensive inspection schemes than those here described have been considered. These generally call for only limited access, if any, to the plants, and for the establishment of a perimeter control with respect to ingress and egress of material, personnel, and equipment. These schemes would weaken, in a most serious fashion, meaningful control of material, for one would not be able to actually measure production and to physically control, with certainty, material produced.

In fact, without access to a plant, one would have no way of knowing that weapons were not in fact being fabricated at the plant.

The problems of determining that no material had in fact left a plant without being properly acknowledged are extremely difficult of solution. As I hope this description has indicated, full access to plants is an essential feature of any system to provide a high degree of assurance against unsuspected diversion.

It should also be pointed out that the control techniques here discussed are, in essence, applicable to inspection of peaceful uses programs under the International Atomic Energy Agency, and the United States Agreements for Cooperation, although they would be modified in terms of extensiveness, in keeping with the character and capacity of the various installations.

FEASIBILITY OF INSPECTION OF CUTOFF

In summary, inspection and control of operating plants producing fissionable material is technically feasible, within the limits of the degree of assurance described, and the costs, in terms of manpower and dollars, are reasonable, although the difficulties of recruitment and drain on technical manpower must be recognized as a serious problem.

Mr. Chairman, I would like to acknowledge the efforts of the many people, both AEC staff and AEC contractor personnel, whose studies and work over a period of years have formed the basis for these remarks.

I want to thank you again for inviting me to testify, and I will be glad to attempt to answer such questions as you may wish to ask.

Senator HUMPHREY. Dr. English, we want to express our gratitude to you.

I believe I am correct in stating that both of you gentlemen worked over the week end to prepare your testimony. You had very short notice, is that not correct?

Dr. ENGLISH. That is correct.

Senator HUMPHREY. I want you to know we are very appreciative of this. It is a real burden upon you to do these things, but the matter of inspection has been a weak spot in all of our testimony. As there is so much talk about summit conferences and agreements and where we ought to meet, I want to know what we are going to meet about and what we are going to discuss when we do meet.

If we are going to discuss disarmament, we cannot discuss it without knowing its many ramifications.

Like most people, I am desirous of easing the arms race and the burden of the arms race if we can, but I want to be sure what we are talking about.

INFORMATION SUPPLIED TO PRESIDENT'S SPECIAL ASSISTANT

Dr. English, did the National Security Council or the former Presidential adviser, Mr. Stassen—I won't bring in Mr. Wadsworth now because he has only been on the job a short time—or anyone else in the executive branch ask you to prepare an inspection paper for the disarmament negotiations such as that you just presented?

Dr. ENGLISH. Sir, I cannot speak for—certainly the National Security Council did not ask me directly. What they asked the Commission specifically, I do not know, but the Commission has undertaken to examine these problems in detail, and there has been an informal group in the AEC which has been concerned about these matters, with representatives from all AEC divisions concerned in the problem. This group has reported to the office of the General Manager, and we have requested, in turn, AEC contractors in the field at the various installations to assist us and to prepare reports and analyze data. This whole operation has certainly had the full support of the AEC.

In fact, it has been at the request of the AEC to its staff that these studies were undertaken so that the AEC would in fact be aware of the problems and that it could make known the problems in the other councils.

Senator HUMPHREY. Yes, sir. I am sure that the AEC has been doing just as you have indicated. We have discussed this with Mr. Strauss a couple of years ago, and from time to time he has assured us of this.

WORK OF TASK FORCES ON INSPECTION

Some time ago I requested of Mr. Stassen and others that we be brought up to date on the task force operations which were assigned to look into various facets of inspection. Everyone on this committee is a peace-loving man, but we have been concerned about the efficacy of an inspection system.

Are you part of such a task force?

Dr. ENGLISH. No, I am not. I know Governor Stassen did have task forces which assisted him several years ago, and I have seen some of their reports. But I personally have not been a member of them.

What I have been concerned with has been the AEC's own studies in arriving at estimates on these problems, and, of course, we have done it for many reasons. One is disarmament. Another is that the same sort of techniques must be examined with respect to the safeguards, that is, the carrying out of the safeguards, under the International Atomic Energy Agency, and also under United States bilateral agree-

ments. The techniques and technical matters are very similar and so we have done it for all three of these reasons.

PREPARATION ON INSPECTION PRIOR TO DISARMAMENT NEGOTIATIONS

Senator HUMPHREY. When this country goes to London to talk disarmament—we are dealing with some cold-blooded, hard-headed, subtle, able people, the Soviets. I do not underestimate them one bit. I would like to know whether, before such negotiations, before we talk about a production cutoff with inspection, whether the information you have brought here has been thoroughly digested by the entire technical staff which is responsible for these discussions. It is one thing to have people at the political—and I am using that word in its best connotations—or statesmanship level discussing agreements or the possibility of agreements with Soviet representatives, and it is another thing to have them filled with adequate information which only technicians can give. My question is whether the material such as you have presented here ever reached Mr. Stassen, or whether it was ever requested by his office, or the National Security Council?

Dr. ENGLISH. Yes; I think the answer to your question, sir, is that it certainly was available to him, and I believe he knew of it.

As a matter of fact, 3 years ago in London, where the U. N. Disarmament Subcommittee meetings were held, the AEC sent two technical people as advisers on the United States delegation. I happened to be one of them.

Senator HUMPHREY. Good.

Dr. ENGLISH. This was not under Governor Stassen. The United States representatives at this time were, first, Ambassador Lodge, and then Ambassador Wadsworth. Three years ago, the Department of Defense also had two people there, so on the staff of the United States delegation there were representatives, technical representatives, from the AEC and representatives from the Department of Defense. This has been the case in each of the succeeding meetings of the U. N. Disarmament Subcommittee.

The AEC has, in fact, had representatives there, and these representatives were fully informed with information as to which systems were believed to be best.

I have presented to you today the most recent information based on the latest studies. Some of these had actually not been made in such detail 3 years ago, but all that was available was known to the AEC personnel who were part of the United States delegation.

Senator HUMPHREY. Thank you very much, Dr. English.

ACCESS OF INSPECTORS TO CLASSIFIED INFORMATION

When we speak of inspection, we generally speak of the U. S. S. R. inspecting us and our inspecting the U. S. S. R.

Another kind of inspection might be by neutral countries; where the U. S. A. and U. S. S. R. do not inspect each other because they were the main nuclear countries. I suppose the British and French and others who are in advanced stages of nuclear development might be involved.

However, let us assume that the U. S. S. R. and U. S. A. were checking each other. Would it not be possible for the Soviet inspectors to learn a great deal about our nuclear operations?

Dr. ENGLISH. I think you would have to assume, in this case, that there would be no such thing as classified information with respect to these operations, absolutely none.

I think the definition of "classified information" in this area would simply evaporate.

CLASSIFICATION OF TESTIMONY

Senator SYMINGTON. Let me ask you a question, if I may interrupt you, Mr. Chairman. Why is this paper classified?

Dr. ENGLISH. As a matter of fact, it is classified because in the short time I had to prepare it, I did not have a chance to have it reviewed. I believe that most of the material I have presented is unclassified, although I did not have a chance to have it reviewed in detail I will do this promptly.

Senator SYMINGTON. I think you have been asked a very good thing to do, and I think you have done it very well. I am one of those people who think that the strength of our country depends upon the knowledge of our people.

Since it is such a good presentation, I do not see why the people should not know about it. Also, it would materially contribute to a question of great national interest—nuclear testing, cessation of nuclear production, and so forth.

Dr. ENGLISH. The only parts which might have to be modified, and then only slightly, would be concerned with any relationship it might show or tend to show about our own production facilities, but I do not think it is classified at all.

But from Friday until today, we did not have time simply to go over it. And we will go back and look it over.

Senator SYMINGTON. Thank you.

Senator HUMPHREY. I would like to say that your paper was very good. I am interested in any kind of bargaining with the Soviets relating to this type of inspection, which seems to have a considerable degree of the alleged foolproof quality to it. Technically, you have a system here that you can operate with reasonable security and reasonable assuredness of its efficiency; is that correct?

Dr. ENGLISH. Right. It is different in the sense that a weapons test is more nearly a go or no-go proposition, you may either detect it or not. The case here is not like that to the extent that if small amounts are diverted, they may escape your notice, but you can set limits on what these could be.

Senator HUMPHREY. It is my belief that it is undoubtedly at the inspection level that the Soviet will really bargain and be tough.

Dr. ENGLISH. I agree.

Senator HUMPHREY. The details of inspection, the freedom of movement, the access to plant and to materials, and personnel, are going to determine whether or not something will work.

Dr. ENGLISH. This is a point at which they will balk; yes.

SOVIET POSITION ON INSPECTION

Senator HUMPHREY. I felt that last summer we somewhat missed the boat with the Soviet Union. In June they indicated for the first

time that they were willing to accept inspection of nuclear weapons tests. They did not say how much or what kind of inspection.

If they had in mind an inspection system such as that in Korea, which we know was inadequate, we would drop the matter.

However, it seemed to me then we should really have pursued their proposal and found out whether they would accept monitoring stations inside their territory. It is the kind of opportunity we are constantly waiting for.

I felt that we let their statement drop without pursuing it. I think before we can ever really even talk in concrete terms about disarmament, we have got to probe the Soviet Union to the maximum degree, asking "What do you mean by inspection? How far do we go, and where do we go?" It takes scientists as well as statesmen and politicians to work out an adequate inspection agreement.

Did you, in your experience with the American delegation at London, ever find the Soviets willing to talk about inspection in constructive terms?

Dr. ENGLISH. No. In fact, the discussions—we were there, the AEC representatives, of course, as advisers in case the discussion reached a point where detailed technical discussions were called for on the part of the United States representatives. The talks never reached a point where any detailed discussions were ever held with the Russians, simply because the Russians never seem to get really far enough into the broader principles underlying disarmament for any of these discussions to ever be fruitful.

INTERNATIONAL AGENCY FOR ATOMIC ENERGY

Of course, in a different international forum, there was an open, public discussion on a plan involving these same techniques and principles in the meetings on the statute of the International Atomic Energy Agency in New York at the United Nations in the fall of 1956.

Senator HUMPHREY. Correct.

Dr. ENGLISH. And here there were many discussions about this, discussions in detail on what safeguards meant, as applied to that sort of operation. But they have not reached this point, so far as I know, in the disarmament negotiations.

Senator HUMPHREY. In that instance the Soviet was willing for the first time to sign an agreement which involved some inspection.

Dr. ENGLISH. But probably not of the Soviet Union. In fact, certainly not.

Senator HUMPHREY. That is correct. However, at least we found two things: No. 1, how the Soviets quibble over all inspection matters; and No. 2, that they did finally sign an agreement. I have a feeling that once there are competent technical advisers who really know the requirements of an inspection system such as you have described, and once the Soviets have indicated by word, deed, or a flicker of the eye that they seriously want to discuss inspection, that is a breakthrough that is second only to a breakthrough in outer space.

I think Soviet acceptance of inspection would be a tremendous political breakthrough, but when they left an opening for us to enter we did not pursue the matter adequately.

REASON FOR LINKING TEST SUSPENSION WITH PRODUCTION CUTOFF

Senator SYMINGTON. Just in your personal opinion, why was it that we premised the crack in the door that we saw in their offer for defense and nuclear testing by demanding a cessation of production agreement also? I am not saying it was right or wrong, but I would just like to know why you feel that that is what we did.

Dr. ENGLISH. Of course, I cannot really answer your question as to why we, the United States, did, because the final decisions on these matters are obviously not ones in which I am personally involved.

Senator SYMINGTON. Yes. Excuse me for interrupting you.

Dr. ENGLISH. Yes.

Senator SYMINGTON. But, as a man of your position in this field, would you not know what the reason was through staff discussion and line discussion of a policy decision?

Dr. ENGLISH. What I can do, certainly, is to give you my own personal opinion as to the rationale which would go along with this sort of a position, and I do think there is a very distinct rationale to it.

Senator SYMINGTON. Yes.

Dr. ENGLISH. Namely, that while testing is an aspect of disarmament, but if one stops testing and continues to make tremendous amounts of fissionable material, continues to stockpile weapons, with no cutoff, then testing is only one very small aspect of disarmament. If one is sincere about disarming, the thing to do is to start cutting back on the materials from which weapons are made.

You would like to see far enough down the road in terms of being able to estimate the sincerity of the nation with whom one is agreeing, if you want to have sincere disarmament. If you do, the proposition is a package, of which testing is only one part.

But in a sense, it is like an analogy someone expressed the other day of two men with guns agreeing, even though they continue to buy rounds of ammunition and more guns, not to have target practice. Really, it is not the whole disarmament picture at all if they were both good shots, as you can say both the United States and the U. S. S. R. are. I think there is a very valid rationale for the linking of the various steps.

Senator SYMINGTON. Then you feel, yourself, that it would be wrong, based on your knowledge and experience, to agree to a cessation of testing unless you correlate with it or coordinate with it a cessation of production; is that right?

Dr. ENGLISH. My personal belief is that this correlation is a rational position and one which I personally favor, because I think it follows logically.

CONTINUATION OF PRODUCTION FOR PEACEFUL PURPOSES

Senator SYMINGTON. As I understand it, it would be very, very difficult to say, "We are going to produce this nuclear material for peacetime purposes only," and then be sure that somebody was not slipping a little away.

For example, if we give a certain amount and continue to give over a period of time, it would be extremely difficult to check what that country was doing with it. I have been told that by experts. Therefore, it would be even more difficult, if the Russians were assuring

us, for example, that they were only making stuff for peacetime purposes, to check that it was only being made for peacetime purposes.

So are you not saying something like this: If we say that we cannot test unless we also stop producing, and then if we say it would be very hard to stop producing unless we stop producing entirely, in other words, stop producing nuclear material for peacetime purposes, are we not really trying to throw what you might term a scientific brake on world progress which does not add up from the standpoint of commonsense?

Dr. ENGLISH. No, sir; I do not think so, because what I have tried to show here is that you, in fact, can tell that there has been a cessation of production for weapons purposes. You can control materials within the limits I have given here, and those limits are that, with the kind of systems here described installed in every production plant, you can suspect a diversion 9 times out of 10, if that diversion is as much as 1 percent of throughput. These limits are such that the amount which could be diverted unsuspected would represent a small amount compared to the now existing stockpiles of material, so that one could not argue that there was much buildup of weapons stockpiles in comparison with those which now exists.

The point I am trying to make here today is that, in fact, it is possible to control, and not hold back, the peaceful uses of atomic energy. What it will cost you is money, manpower. But there, I personally think, are reasonable in terms of the money that is going into the operation now, and certainly reasonable in terms of money being spent on armaments. The risk you take is within the limits of your inability to determine small diversions.

Senator SYMINGTON. But you have got to have complete inspection, have you not?

Dr. ENGLISH. In my opinion, yes, sir; you do.

Senator SYMINGTON. And that is going to take an awful lot of people.

Dr. ENGLISH. It is going to take the numbers of people here indicated.

PERSONNEL REQUIRED FOR INSPECTION OF SOVIET UNION

Senator SYMINGTON. How many people would that be which you estimate we would have to have in Russia?

Dr. ENGLISH. I have not actually tried to make an estimation for Russia. Perhaps, although I would have to qualify this very seriously, I could make an estimation for the United States—in fact, I have thought about this a bit. Let me take as an example a country having the number of installations that the United States now has, and if one includes in this the small reactors there are very many. There are plants at Arco, Idaho, which would have to be inspected. There is the power reactor operating at Shippingport, Pa., and other power reactors. One must include a team of inspectors for seeking clandestine operations, which of course we know would not be actually necessary in the United States, but certainly would be necesary to include in our estimate. Thus, taking the case of another country, with roughly the same number of installations as the United States, I think something of the order of perhaps 3,000 to 3,500 people would be required, of which somewhat less than 20 percent would have to be scientists and engineers.

Senator SYMINGTON. You see, the Republican minority leader put in the record several years back it would take several hundred thousand Americans to be in Russia in order to properly police it. I think it was between 400,000 and 500,000 people. It might be 200,000 to 300,000, but it was in that realm; I know it was in the hundreds of thousands.

Dr. ENGLISH. Well, I do not want to have any great weight or significance attached to the total number I gave. The total I gave for a given type of installation is reasonably good, I think, but in trying to sum up the total, it depends on what facilities you included, and I have attempted to include feed processing plans, reactors, production complexes, at the various places and other installations which would have to be inspected.

Senator SYMINGTON. And you have not made any analysis in your mind of how many people we would have to have in Russia?

Dr. ENGLISH. I have not.

Senator SYMINGTON. Who has? It is a vitally important matter.

Senator HUMPHREY. Senator, is it not true we assume we have at least as many plants in the United States as they have in the Soviet?

Senator SYMINGTON. You know you cannot do that. I know how many men it would take me to inspect another man's establishment, when I am dealing with somebody I trust. But I do not know how many people it would take me based on the record of somebody I could not trust. I think it is a very important point, Mr. Chairman. And I would like to suggest that inasmuch as this administration says, No. 1, we cannot have suspension of testing without also having production cessation, and, No. 2, in order to do that we will have to have a lot of people in Russia to assure ourselves that they will not produce after they agree they will not produce, then I think it is of major important that we know a great deal more about how many people it would take to carry that out.

I am sure the Chair agrees with me on that.

Senator HUMPHREY. Yes.

Dr. ENGLISH. You see, the information on the estimated number and disposition of facilities in Russia is not known to me, so I could not——

Senator HUMPHREY. Perhaps we can get this information from Dr. Scoville tomorrow, who is the Director of Scientific Intelligence for CIA.

You estimated that slightly over 3,000 inspection personnel would be required in the United States; is that correct?

Dr. ENGLISH. For a country with the number of installations that the United States has, yes, but perhaps I should make it somewhat larger and say approximately 4,000, because this is a number concerning which I really have not made any firm estimate. The numbers I gave you in the statement I do think are reasonably accurate, but this total is really only a guess.

BREAKING UP THE DISARMAMENT PACKAGE

Senator HUMPHREY. A suggestion has been made to divide up the disarmament package. An argument which I personally made is that you could divide test suspension with inspection, from a cutoff of production of fissionable materials for weapons purposes with

inspection. You could divide them, even though they would be better together because if either one of them could be negotiated, it would be a beginning toward a more secure inspection system and have a tendency to lead to the negotiation of the other.

In other words, if you could get, let us say, a test ban with inspection, you could have a setup of inspection machinery which would require some mobility and some freedom of access just by the fact that you were trying to register any violation of bomb tests. By the same token if you could get inspection for the cutoff of production of fissionable materials for weapons purposes, you would again have technicians, inspectors, and atomic energy specialists on location. Although inspectors for a cutoff would not necessarily be able to ascertain a bomb test, they would be within the environment of the atomic energy production system and this would promote a situation which would be conducive to further agreements.

This is the kind of rationale which has developed on my part.

I believe that the main thing is to get hold of this inspection. One of the main reasons for pressing for a suspension of the bomb tests, is to see whether or not the Soviet Union will ever accept a group of inspectors who have the right to monitor tests and to ascertain what is going on.

It seems to me that has political significance far greater than even a year or 2 years' agreement on bomb-testing suspension, or even a cutoff of nuclear materials production. I think essentially the problem with the Soviet Union is not a problem of science but a problem of politics.

We have as many good scientists, or better ones, if we put them to work. Our problem is that the Soviet Union is a monolithic, tyrannical, dictatorial society, and we cannot get to them. We cannot get behind that rhinocerous hide that holds out observers and keeps in information.

I have one additional question.

INCLUSION OF CHINA

I call your attention to your statement which said:

> It is possible to imagine attempts to conceal the existence of plants. Such an attempt could be successful if access to large territories of a country is not permitted.

The Soviet Union has a very good political working relationship with China, which is one of the largest areas of the world.

One of my concerns which I have expressed repeatedly, is that any type of disarmament agreement, particularly if it relates to this area of atomic energy weapons or production of fissionable material, which does not include China contains the risk that the Soviet Union will just uproot and move whole plants, necessary personnel, and even possibly provide armed forces to protect their personnel.

Let us assume the Chinese themselves did not intend to be too hospitable to the Soviet Union over a period of time. Is there anything to prevent the Soviet Union from saying, "It is worth whatever risks we must take to put a million men in here to protect these plants."

Senator SYMINGTON. Mr. Chairman, I have a luncheon date at 12:30. Excuse me, Mr. Chairman.

Senator HUMPHREY. We are going to recess very shortly.

Dr. ENGLISH. I think your point is very well taken, and this certainly is a problem, a very serious problem, with respect to plants. If you can imagine all Russia has to do is shift operations to uninspected territory, then inspection means nothing. As to tests, if Russia agreed to a test limitation and then suddenly there was a series of explosions in Red China which you detected, and Russia said they knew nothing about it, that would be a most serious problem.

Senator HUMPHREY. I brought this up to Mr. Stassen the other day when he said the test ban might be limited to the United States and the U. S. S. R. The political leaders of a country might decide there was enough merit or value in getting the beginnings of a disarmament agreement, including inspection, with the U. S. S. R., so that they might want to take these risks.

However, the Soviet leaders are diabolical, clever people, and it is entirely possible they might try to divert materials or even weapons themselves into a country like East Germany or Poland or someplace else, and have that country test the weapons.

What this subcommittee is trying to do is to pin down those possible escape hatches and to look at the proposal with a constructive critical eye.

My inclinations are to seek the agreements and to press hard for them, but I think we have to know every time the full implications of what we are doing, because we are dealing with very clever people.

Thank you very much, Dr. English. I want to again express my deep personal appreciation to you and to General Starbird for, first, your service to the country and to the Government; and, second, your willingness to come over here and give us advice and counsel.

That goes to both of you distinguished gentlemen.

Dr. ENGLISH. Thank you very much.

(Whereupon, at 12:45 p. m., the subcommittee adjourned.)

CONTROL AND REDUCTION OF ARMAMENTS

TUESDAY, MARCH 25, 1958

UNITED STATES SENATE,
SUBCOMMITTEE ON DISARMAMENT OF THE
COMMITTEE ON FOREIGN RELATIONS,
Washington, D. C.

The subcommittee met, pursuant to call, at 4:10 p. m., in room F-39, United States Capitol Building, Senator Hubert H. Humphrey (chairman of the subcommittee) presiding.

Present: Senators Humphrey, Sparkman, Symington, and Flanders.

OPENING REMARKS OF THE CHAIRMAN

Senator SPARKMAN (presiding). The committee will come to order. Senator Humphrey, the chairman, is temporarily delayed. I'm going to read a statement prepared by him [reading]:

The purpose of today's hearing of the Subcommittee on Disarmament is to continue the subcommittee's study of the control and reduction of armaments.

Our current series of hearings concerns the control of nuclear weapons. We are particularly interested in information on detection of nuclear weapon tests, a very crucial matter in determining whether it would be possible to devise an inspection system adequate to verify agreement to suspend such tests. The subcommittee already has heard from several officials of the executive department on this subject, and in the near future we expect to hear additional experts in this field.

INTRODUCTION OF DR. HARRISON BROWN

Our witness this afternoon is the distinguished author and professor of geochemistry, Dr. Harrison Brown.

From 1943 to 1946 Professor Brown was the assistant director of chemistry of the Clinton Laboratories at Oak Ridge. From 1946 to 1951 he was associated with the Institute for Nuclear Studies at the University of Chicago, and since 1951 he has been a professor of geochemistry at the California Institute of Technology.

Dr. Brown is a member of the National Academy of Sciences and is chairman of its Committee on Oceanography. He has written several books which reflect his great concern for the control of nuclear weapons, and the future of mankind, including: Must Destruction Be Our Destiny, The Challenge of Man's Future, and The Next One Hundred Years.

Dr. Brown, we are delighted to have you with us and you may proceed in your own way.

STATEMENT OF HARRISON BROWN, PROFESSOR OF GEOCHEMISTRY, CALIFORNIA INSTITUTE OF TECHNOLOGY

Mr. BROWN. Thank you very much, sir. I appreciate the invitation of this committee and I have tried in a very brief statement which I have prepared on short notice to answer most of the questions which were raised in the chairman's letter of invitation.

I shall be glad to expand upon these answers in the period which follows.

PROBABLE CONSEQUENCES OF ARMS RACE

I would like first to outline briefly what I believe will be some of the probable consequences if the world continues along its present path without achieving a substantial measure of control over modern methods of large-scale destruction.

The most immediate danger, of course, lies in the possibility of an all-out nuclear war with the Soviet Union. But as the years pass, other dangers will quickly emerge which will present problems even more serious than those which now confront us. These new dangers will result first from the spread of nuclear-military capabilities to other presently industrialized nations.

Second, they will result from the spread of industrialization, and with it the power of waging modern nuclear war, to the large areas of Asia, Africa, and South America.

NUCLEAR-MILITARY CAPABILITY

Today there are three nations which possess nuclear-military capabilities and a fourth will emerge shortly. It would not surprise me if 15 nations were to possess these capabilities in another 25 years. In 50 years the number may well be 30.

EFFECTS OF SPREAD IN NUCLEAR CAPABILITY UPON ACHIEVING AGREEMENT ON CONTROLS

As these capabilities spread, the difficulties of achieving controls of any sort will be multiplied manyfold. As each new nation achieves the ability of manufacturing and using nuclear weapons, we will pass through successive "points-of-no-return" where both the political and technological problems of control will be increased enormously.

When we couple these considerations with the rapid strides which are being made today in delivery systems and in the offensive aspects of undersea warfare, the future would appear to be fraught with the gravest of perils.

If New York, for example, were destroyed today, we could be quite sure that it was either an accident or the result of Soviet action and we would act accordingly. But if New York were destroyed 15 years from now, it might be literally impossible to determine the identity of the aggressor.

SUSPENSION OF NUCLEAR WEAPONS TESTS

It seems to me that it is very much in the interest both of the United States and the Soviet Union to slow down the rate of spread of nuclear-military technology in the world as much as possible. I be-

lieve that one of the more effective approaches to this, and by far the least difficult to carry out in practice, would be to secure a worldwide moratorium upon the testing of nuclear devices which possess certain specifiable characteristics.

EFFECTS OF NUCLEAR WEAPONS TEST SUSPENSION

In recent months there has been vigorous discussion of the pros and cons of testing, and some persons who are deeply engaged in the weapons-development field have stated that continued testing is necessary if we are to keep ahead in the development of both offensive and defensive weapons systems. I am convinced that the proponents of this view seriously underestimate the long-range dangers which may result from the pursuit of this policy. I believe that the risks inherent in a policy which would hinder nuclear-military developments on a worldwide basis would be negligible when compared with the risks inherent in a situation in which controls are nonexistent.

FIRST STEP AGREEMENT

I would like to outline briefly the kind of initial agreement which I believe would be generally politically acceptable and technologically feasible. First, we could agree upon a suspension of tests for a fixed period long enough for an international panel of scientists, representing the various areas of knowledge involved, to work out the specifications for a worldwide network of detection stations. This period might be somewhere between 1 and 3 years.

Such a network could take any one of a number of forms. As an example, we might consider an assemblage of stations spaced over the land areas of the earth at 1,000-mile intervals, each of which would be equipped with the most sensitive of seismic, barographic, radiation detection, and other instrumentation. The stations would be manned by an international staff and would be in daily communication with a central detection headquarters. The stations could, if desired, be placed at closer intervals than 1,000 miles, thus achieving even greater sensitivity.

Second, knowing the characteristics of this network, we might then agree to ban all tests which could be detected and identified by the established system. This would mean that one could not let much radioactivity into the atmosphere or generate any appreciable air pressure waves. With respect to underground explosions, I am convinced that a system such as that which I have described could be designed which could detect, locate, and positively identify explosions above a certain minimum energy, which would lie somewhere in the kiloton range. The precise sensitivity would depend upon the nature of the rock in the vicinity of the explosion.

However, the exact sensitivity is not the important factor. The most important aspect of the system would be that the really large explosions would be completely eliminated from the world scene.

I would like to stress that at this stage I would not advocate the banning of all nuclear weapons tests for the simple reason that a much more elaborate system would be required to monitor the very small explosions. Nor would I be inclined to specify the maximum energies of tests. We should, I believe, keep this first step toward

arms control as simple and uncomplicated as possible and simply agree not to conduct any tests which can be detected and identified by the established system. In other words, I would create a symmetrical situation so that the scientists of our own country would be as free as those of others to attempt to devise ways and means of testing within the framework of the restrictions.

SEPARATION OF CUTOFF OF FISSIONABLE MATERIAL PRODUCTION FROM FIRST-STEP PROPOSAL

Above all, I would avoid linking a proposal such as this with any other which would either decrease the chances of securing agreement or which would greatly increase the technological complexities. For example, although I am all in favor of establishing international controls over the production of fissionable material, the latter is a far more complex problem and should not be brought into these initial discussions.

LIMITATIONS OF FIRST-STEP AGREEMENT

I do not believe that an agreement such as I have described would be the answer to the immediate problems of war and peace which now confront us. It would not change the fact that both the Soviet Union and the United States have vast stockpiles of nuclear weapons, ready for use when needed. Such an agreement would, however, keep matters from getting considerably worse than they now are. It would buy us time.

It would greatly lessen the problem of atmospheric contamination. And above all, it would be an agreement, which, if successful, could be the beginning of a sequence of agreements which would lessen the dangers of nuclear holocaust.

MISSILE MONITORING DEVICES

If such a network were formed, the individual stations could be used later as sites for the construction of missile monitoring devices. This would be a considerably more expensive task, but there seems to be little doubt that effective monitoring could be achieved. Missile monitoring is, I believe, fully as urgent a problem, and perhaps even more urgent, than the monitoring of nuclear tests, for the reason that it is with missiles that the bombs will be delivered. I propose it as a second step only because it is a more difficult problem technologically.

CONCLUDING REMARKS

Given these first steps it is conceivable that the way will be paved for much more sweeping agreements which might help us lessen still further the enormous dangers which confront us, before it is too late.

LETTER INVITING DR. BROWN TO TESTIFY

Senator HUMPHREY. Thank you very much, Dr. Brown. I think the letter to Dr. Brown in which I posed eight particular questions for his observations, and which he has done in his prepared statement, should be made a part of the record.

(The letter referred to is as follows:)

MARCH 21, 1958.

Dr. HARRISON BROWN,
Care of Dr. H. Walton Smith,
The Marine Laboratories, University of Miami,
Virginia Key, Miami, Fla.

DEAR DR. BROWN: As chairman of the Senate Subcommittee on Disarmament, I am pleased to invite you to appear before the subcommittee on Tuesday, March 25, at 4 p. m. I understand that, since your business takes you to the East, this date will be convenient for you.

The subcommittee is concerned with many aspects of the relationship of current disarmament proposals to our national security. In view of your particular experience and competence, your views regarding the control of nuclear weapons, particularly the matter of nuclear-weapons tests, will be extremely helpful.

You should feel free to discuss any matter which is relevant to the subcommittee's inquiry. I would like to suggest, however, a few questions on which the subcommittee needs to have further testimony.

1. How would you describe the risks of undertaking some first-step arms-control agreement versus the risks of not taking any steps?
2. What are the advantages and disadvantages of separating a proposal for an agreement to suspend nuclear-weapons tests from a proposed agreement for the cutoff of fissionable materials for weapons purposes?
3. If nuclear weapons tests were suspended as a result of an agreement, what should be the length of any period of the suspension? What are the advantages and disadvantages of an agreement to suspend nuclear-weapons tests?
4. To what extent can an inspection system be devised to assure that a violation of an agreement to suspend tests would be detected?
5. Can you suggest the type of inspection that would be necessary?
6. Should an agreement to suspend tests contain provisions to allow research and testing under international auspices for the peaceful use of nuclear explosives?
7. Under what conditions should a suspension of nuclear-weapons tests be continued or stopped?
8. If weapons tests were suspended as a first-step arms-control agreement, what aspects of the control and reduction of weapons should be pursued as a second step?

If you prefer, you may have an opening statement, although I suggest any such statement should be limited to 15 minutes.

To give you some background on the work of the subcommittee, I am enclosing its unanimous report of last September.

I am looking forward to seeing you on Tuesday.

Sincerely,

HUBERT H. HUMPHREY.

Senator HUMPHREY. Senator Sparkman, would you like to question Dr. Brown?

Senator SPARKMAN. Not at this moment. I will pass.

Senator HUMPHREY. Senator Symington.

PARTICIPANTS IN A TEST-SUSPENSION AGREEMENT

Senator SYMINGTON. Doctor, in your statement when you say, on page 2:

* * * we could agree upon a suspension of tests for a fixed period long enough for an international panel of scientists—

"we" would be who?

Mr. BROWN. I believe, sir, that at the very minimum the "we" should be the existing nations which possess military nuclear capabilities. I, personally, would prefer this to be on a much broader base, preferably through the United Nations, for the simple reason that, in the long run, this will not be effective unless it is worldwide.

Senator SYMINGTON. As of now, then, that would be the Soviet Union, the United Kingdom, and ourselves?

Mr. BROWN. That is correct.

SIZE OF PERMISSIBLE TESTS

Senator SYMINGTON. At the bottom of page 2 when you talk about "* * * at this stage I would not advocate the banning of all nuclear weapons," what, roughly, would be those that you would think we could test in strength and those we could not?

Mr. BROWN. Given a network such as I have described, there would be a minimum cutoff, depending upon the nature of the land, below which in energy you would not be able to detect the test. Tests in that area should be quite permissible. If you are able, by some ingenious invention, to test some other kind of nuclear explosion of a higher energy, I would be perfectly in favor of permitting that, provided it is not detected by the detection system, for the very simple reason that there is little point in having a ban on something where you have no control over the ban.

Senator SYMINGTON. Let's try and get a little more specific. Are you in favor of testing kiloton weapons and not testing megaton weapons, or are you in favor of testing some kiloton weapons and not others?

Mr. BROWN. As I would visualize it, sir, the most immediate problem that confronts us is to abolish the really large babies, the really large explosions. If we had a system which would detect anything greater than 5 kilotons, for example, then we would say that anything over that will be illegal.

CATEGORIES OF EXPLOSIONS

In actual practice, I believe that one could quite readily establish three categories of explosions. The first would be the forbidden category. The second would be a conditionally permitted category.

For example, let us suppose you wished to use a 10,000-ton explosion for some peaceful purpose. You would announce in advance that you are setting off this 10,000-ton explosion for this purpose. It would be picked up. It would be identified, but, under such circumstances, you would have to have individual, personal, human inspection in order to ascertain the validity of the statement.

Senator HUMPHREY. Didn't you have a third category?

Mr. BROWN. The third category would be the unconditionally permitted, which would be all tests that could not be detected, and there we are referring primarily to the very, very tiny ones.

Senator SYMINGTON. Then you think there are other things that have to be taken into consideration, in addition to the actual strength of the bomb itself.

Mr. BROWN. Yes. You see, a detection system will work. It has to receive an impression of some sort, and the kind of impression it receives depends not only upon the energy of the bomb but upon the kind of medium within which the bomb is exploded.

DISTINCTION BETWEEN NUCLEAR EXPLOSIONS AND EARTHQUAKES

Senator SYMINGTON. Now, we have talked a lot about detection, and I would like to ask a question about distinguishing whether an explosion was an earthquake or whether it was an underground, man-planned, nuclear explosion. Would you care to comment on that?

Mr. BROWN. Yes. When you get down to the very small explosions, it is quite difficult to differentiate them from earthquakes. By very small, I am thinking, let us say, of the order of 1 kiloton, and it is particularly difficult at large distances. When you get to the larger ones, high in the kiloton range, then the nature of the wave patterns on the seismograph is visibly different, and it is possible to make this distinction.

Now, in the energy range in which we are interested on a world-wide basis there are about 1,000 earthquakes a year. This would mean that there would be, roughly, 1,000 records which would have to be evaluated from the point of view of determining whether or not those were really earthquakes or explosions.

Now, with a network, you can conduct triangulation. You can locate where the shock originated. You can tell a great deal about the depth, and, as long as it is a fairly large one—by "fairly large," I mean in the upper kiloton range, let us say—you can readily distinguish it from an earthquake. If you were interested in monitoring lower ones, smaller ones, then it would require, once you found out where the shock had taken place, it would require a human crew going in to actually see what had happened.

Senator SYMINGTON. Mr. Chairman, I have great respect for Dr. Brown's opinion, and his book—is it entitled "A Challenge to Man's Future"?

Mr. BROWN. Of Man's Future, sir.

Senator SYMINGTON. It is one of the most stimulating books I have read.

CONFLICT BETWEEN TESTIMONY IN PUBLIC AND EXECUTIVE SESSIONS ON DISTINGUISHING OF NUCLEAR EXPLOSIONS FROM EARTHQUAKES

It is a fact, however, that your testimony in open hearing on this particular subject, with respect to distinguishing as against detection, is not in accordance with some testimony that we have had in executive session by other experts in this field. I would respectfully ask the Chair that the testimony we had on this question from one of the witnesses in the last executive hearing be turned over to Dr. Brown; that he analyze that testimony, and then either give a position in a classified paper to the committee or be heard again in executive session, because, of course, what we are talking about now is the kernel of much of this problem.

Senator HUMPHREY. I think it would be desirable, Senator, possibly at a later date, that we have Dr. Brown with us to discuss this matter with one of the other witnesses we have had, because the study of this committee in the past month or so has been centered around inspection and detection, both in theory and practice. A great deal of information has been furnished thus far. We will get into it more as we go along.

SOURCE OF INFORMATION

Mr. BROWN. May I make a comment in this connection, sir?

Senator HUMPHREY. Please do.

Mr. BROWN. Every statement that I have made and will make is obviously of an unclassified nature, and indeed I do not personally have access to classified information in this area. And indeed this kind of information is very difficult to come by. I have discussed these matters at great length with highly respected individuals who are knowledgeable about the nature of earthquakes and frequency and the pattern that are set up, and indeed a great deal of the information which I have here is not of local origin but, oddly enough, of Japanese origin.

PROBLEM OF SECURING INFORMATION

It is easier for a nongovernmental employee such as myself to obtain information from the Japanese than from our own Government.

Senator HUMPHREY. I can assure you that we are attempting to release as much information as possible relating to the studies we are making, without any violation of what the agencies consider the most sensitive of material.

I think this ought to be released, so that there is better understanding. I am interested in what you said about the availability of information elsewhere. Of course, there is a good deal of information available on this seismograph material from other sources. Go ahead, Senator Symington.

Senator SYMINGTON. Thank you.

Mr. Chairman, I think it is extraordinary that Dr. Brown does not have access to this information. Unless he has some objection, I suggest that we do our best to see that he does have access to it, and, more specifically, I would suggest that he read the testimony given in classified session of Mr. Northrup and Dr. Scoville, the latter of the CIA, if that meets with the Chair's approval.

DETECTION OF TESTS CONDUCTED ON SUBMARINES

Dr. Brown, another question that worries me about this testing is this: As we know now, the Soviets have a great many submarines. That seems to be universally acknowledged, and there are many ways of testing bombs. You can test them under the water. You can put a balloon up of some character from a submarine. You could run a surface test from a submarine many thousands of miles away from any land.

Suppose that we entered into an agreement, and our country honorably lived up to its agreements, and somebody else made one of these tests from a submarine and then said that we did it. Of course, we would say that they did it. How would you handle that in an agreement?

Mr. BROWN. That, sir, would be an extremely difficult thing to handle. Certainly, the fact that the test had taken place would be virtually impossible to conceal. With an underwater explosion, you do not even have to have ships to detect it. You can detect an ordinary dynamite explosion literally hundreds and hundreds of miles away

underwater. I would be inclined to handle it in this way, and that is to have, as an integral part of the inspection system, units over the oceans. These would be ships with monitoring devices similar to those which would be over the land areas, and, in addition, I would be inclined to have on a number of these ships airplanes which could scout once a particular explosion had been pinpointed. Obviously, such would not be foolproof, but I believe that what would happen—after all, this would be an agreement between sovereign states, and if one thing like that did happen—it would just mean the end of the agreement.

NEED FOR TESTING TO REDUCE FALLOUT

Senator SYMINGTON. The next question I would like to ask has to do with clean weapons. As you know, there are several important aspects of a clean weapon. One is its use in limited war. God grant that we won't have any wars in the future, but we have had limited wars in our own time and limited wars in other centuries, and the idea of a clean weapon can first be incorporated in some concept of a limited war. Secondly, some of the real authorities in this field believe that there is no defense against ballistic missiles if you eliminate a defense which embraces the utilization of nuclear weapons, and, of course, you would not want to spray your own cities with fallout.

Third, we get into the whole question of whether or not we are going to continue peaceful application of nuclear explosions. For example, you have a great deal of thinking now that has been generated by such tests as the Rainier Mountain test, where so many hundred thousand tons of earth were moved, where there is a possibility of preserving heat to generate power, and so forth. As a result of that type and character of problem, many people feel that testing should go on to establish what has been called by various experts in this field, a clean bomb. What would be your comments on that?

Mr. BROWN. If I might take the last part of your question first, the peaceful use of nuclear explosions, it is rather clear that you do not gain very much, that humanity could get along very well, I believe, if one limited the size of peaceful explosions. I doubt that one would ever have much occasion to use anything over 10 kilotons, although I do understand the Soviet Union, I have heard that the Soviet Union is planning the explosion of about 30 kilotons for some kind of a construction job. But this, I think, can fit very nicely into the kind of pattern that I described.

Concerning the arguments that are raised to continue the testing of the larger explosions for defensive purposes, I believe that this is really a never-ending spiral; that once you test for that and you develop something better and along the defensive line, then you have got to test to develop something better along the offensive line, and then you have to develop the defenses again, and there is just no end to it until something happens. As a result, I believe that the testing of such large weapons should be banned, and I believe that the risks involved—I agree with you that there are risks——

Senator SYMINGTON. I have not taken any position. I am just asking questions.

Mr. BROWN. I am sorry; I misinterpreted you. There are a certain number of risks, but I believe that those are negligible when compared with the risks of our pursuing the present policies.

EFFECTS OF HIGH-ALTITUDE TESTS UPON OUR DEFENSE

Senator SYMINGTON. Two more questions. One has to do with the question of testing at very high altitude. We understand there is a possibility that a heavy explosion at high altitude might eradicate all radio response. In other words, black out your radio system, which would, of course, work against any detection apparatus that we had and destroy a good many billion dollars of investment we have already made. That either is true or is not true. How would you find out a situation like that? I am being the devil's advocate now. These are important questions on which I know you want us to try to get as much information as we can to the people.

Mr. BROWN. Yes. I believe that it would be quite difficult to carry out an explosion at high altitudes without its being detected, for the reason that I doubt that you could dispense entirely with the radioactive products of the explosion.

Senator SYMINGTON. I do not think my question was clear. If we agreed to suspension—which worries me, particularly if they are ahead in the development of the utilization of this nuclear power in weaponry—then how could we find out, without testing, that our preparations for defense—and we are basically a defensive nation—would be nullified by an explosion of that character?

Mr. BROWN. That I believe is one of the risks that would have to be taken, but the situation would be completely symmetrical.

Senator SYMINGTON. Provided our feelings toward them were the same as their feelings toward us.

Mr. BROWN. That is provided they did not test in this way, and if they did, we would be able to detect it, I am convinced.

Senator SYMINGTON. And you feel that we would?

Mr. BROWN. Yes.

Senator SYMINGTON. In a fairly short period of time, even if it was a test way up in the stratosphere?

Mr. BROWN. This would depend upon how much time elapsed between the initial banning of the test and the time of the test, because it would depend upon, in part, the background of the level of radioactivity which exists in the atmosphere.

Senator SYMINGTON. Thank you, Doctor.

UNDETECTABLE TESTS

Now I have one more question. Somebody wrote me a note that you discussed the question of bootlegging. I do not know whether you did or not. You were reported as having said something about the fact that bootlegging would be wrong if it was detected, but if it was undetected that would be just that. Is there any accuracy in that comment?

Mr. BROWN. No. I believe what is being referred to there is essentially what I have described here, where we set up a network of detection and then in effect we say that all tests that cannot be detected are legal.

In other words, we legalize the bootlegging of tests, you see. I am quite sure that that is what is being referred to there, because I used that expression in a talk which I gave a couple of weeks ago in Minneapolis.

Senator SYMINGTON. But then would we all be trying to bootleg?

Mr. BROWN. We would all, I believe, certainly, if we had a network, we would attempt to find out what kinds of tests our persons in Livermore, Los Alamos, and so forth, would continue to be working, I believe, in order to find out how this network could be circumvented. It is of very much interest to know.

Senator SYMINGTON. Our country is a country of free men, and they would know our country had made a pledge which should be honored. But, from what I hear, the scientists in the Soviet Union are not independent from what they consider to be a point of personal honor, as our scientists are here. I hear, for example, the experience of Professor Kapitsa. Therefore, if bootlegging is all right for everybody, but our people don't want to bootleg because they think it is dishonorable for a nation to pledge it's not going to do something and then do it, and if by any chance the Soviet Union felt it was not dishonorable to say they would not do something, and then do it, haven't we got a difficult situation from the standpoint of our future security?

Mr. BROWN. Perhaps I didn't make myself clear, sir. I would visualize that we would agree to one thing, and that is we would ban all tests which could be detected by the existing system.

Any other nuclear explosions which you wished to conduct which could not be picked up by the instrumentation of your network would be legal in effect. We have only agreed to ban those which can be detected, and that would exclude certainly all of the big ones and a vast majority of those of intermediate size.

Senator HUMPHREY. Would you yield to me at that point?

Senator SYMINGTON. Mr. Chairman, I would like to yield the floor, if I may, but before doing so I would like to make this comment. This I think is a very tricky discussion right at this point. I want to see us do everything we can, but I am not quite clear what we should do. I want to thank you, Doctor, for your very intelligent answers to these questions and for the interest you have in this vital subject.

Mr. BROWN. Thank you very much.

EFFECTS OF PERMISSIVE UNDETECTABLE TESTS

Senator HUMPHREY. I want to call on Senator Flanders, but just to follow up on Senator Symington's question I was concerned with, and marked in your prepared manuscript, Dr. Brown, that portion about the bomb tests which were to be detectable and the area that would be undetectable. It seems to be a little fuzzy in terms of where that line is, and, as I understand you to say, we will ban the tests of the bombs that can be detected.

Mr. BROWN. Yes.

Senator HUMPHREY. And those that are not detectable would be in a sense legal.

Mr. BROWN. Yes.

Senator HUMPHREY. Now doesn't that kind of a line invite attempts to violate, since you are never quite sure just what size bomb will be detectable? It depends a great deal upon such factors as where the tests are made, the environment and the nature of the bomb itself. Therefore, if you leave a sort of legal alley here, an escape hatch, don't you invite entrance into it?

Mr. BROWN. It is in part for that reason that I suggested the three areas, the unconditionally forbidden, the unconditionally permitted, and an in-between area where you can announce that you are going to explode a bomb of a certain size, and which on occasion could be done.

Senator HUMPHREY. Dr. Brown, what worries me is that under your proposed formula, detection of a bomb explosion would signal the annulment of the agreement. I thought you weakened your case on detection this way. After having listened to a considerable amount of impressive testimony, I am not so worried as some might be about whether or not we can detect, particularly if you have the network of detection, devices and systems such as you are advocating and as others have advocated. I want to press the point with you a little more, in my respect for your knowledge in this field. But, before I do so, I want to ask Senator Flanders if he has questions which he would like to ask.

Senator FLANDERS. Mr. Chairman, I appreciate being invited to listen to the testimony of Dr. Brown. The same point that has been discussed by our chairman and Senator Symington attracts my attention also.

It seems to me that in the first place we cannot control anything we cannot detect. That is fundamental. And to say that we are going to control anything we cannot detect is just plain folly.

Mr. BROWN. That is right.

VALIDATION OF DETECTION SYSTEM

Senator FLANDERS. So that that brings you inevitably to the point of view that you expressed. Now am I right in this: That the second type of explosion could well be an experimental type of explosion to see how big a bang you can have that was undetectable to these stations a thousand miles apart, so that you could then begin to get data on what is detectable and what is undetectable. Was that the point?

Mr. BROWN. That is in part the point, sir; yes.

Senator FLANDERS. Is there more to that point than what I just said?

Mr. BROWN. No; with this one exception. I believe that in the establishment of this network, after consultation on an international level between persons who are knowledgeable in the nuclear military field, certainly some experimentation would be in order once the network is established under international auspices in order to see just how effective is this network.

Senator FLANDER. Yes.

Senator HUMPHREY. That is different, may I say, than having an indefinite line. That is what you would call permissive, scientific testing for the purpose of validating the detection system?

Mr. BROWN. That is true.

Senator HUMPHREY. That to me is entirely different. That is something you could agree on.

Mr. BROWN. Yes.

Senator FLANDERS. That is a possibility.

PACKAGED PROPOSALS

Now aside from the scientific aspects of your testimony, which of course go far beyond any personal knowledge or experience of my own, I am somewhat intrigued by a political element in what you have suggested. Take the bottom of page 2:

Above all, I would avoid linking a proposal such as this with any other which would either decrease the chances of securing agreement or which would greatly increase the technological complexities.

That to my mind is an argument against these package proposals.

Mr. BROWN. Yes.

Senator FLANDERS. We offer a package, say "Take this, this, and this, and unless you take the whole package you do not get anything." This is an argument against the package.

Mr. BROWN. Yes.

Senator FLANDERS. I would like to have that point established, because I think this package thing is a pernicious thing, provided you can get a complete self-consistent self-contained proposal such as you evidently are seeking for in this thing. I hope, Mr. Chairman, that our future negotiations can take some advantage of the type of proposal which Dr. Brown is making here this afternoon. I think that is all I have.

Senator HUMPHREY. Thank you very much, Senator Flanders.

Senator SPARKMAN. Mr. Chairman, may I ask just one question at that point.

Senator HUMPHREY. Please do.

RELATION OF DISTANCE BETWEEN STATIONS AND RELIABILITY OF DETECTION

Senator SPARKMAN. You propose these stations a thousand miles apart. If they were placed nearer each other, would the scale subject to detection go down?

Mr. BROWN. Yes. One could take a choice here. Obviously if you had your stations closer together, then you could detect smaller and smaller explosions. Or you could use less and less expensive equipment, and that would enable you to get by with less cost, although here cost is really of no importance.

Senator SPARKMAN. And if the stations were equipped with inspection teams, would that make a greater degree of detection possible?

Mr. BROWN. This would depend upon whether you had as a part of the initial agreement that any seismic record which had been located and which had not been positively identified, then you would have permission to go in and look at that area.

Senator SPARKMAN. I would assume that.

Mr. BROWN. Yes.

Senator SPARKMAN. Or else you would not need the team.

Mr. BROWN. If you did not have that agreement, then I would visualize the person who operated an individual station as being sort of like a lighthouse keeper. He would not interefere in any way with the other aspects of the military security of the country in which he was stationed.

MEASURING AND DETECTING EXPLOSIONS

Senator HUMPHREY. Dr. Brown, on the seismic detection that you emphasize, I know you realize better than any of us that there are

many other ways of measuring and detecting explosions or energy output. For example, the detection of an acoustic wave would be part of a detection system; would it not?

Mr. BROWN. That is essentially mentioned in my statement, the barographic or the microbarographic.

Senator HUMPHREY. And then the electromagnetic.

Mr. BROWN. Yes.

Senator HUMPHREY. That would be another, and radioactivity.

Mr. BROWN. You would have incorporated in each of these stations every instrument which was known to enable you to detect something; yes.

Senator HUMPHREY. And with free flow of information between the respective stations.

Mr. BROWN. You would visualize that each individual station would channel its information daily into a central communications center and evaluation center where the data would be processed as soon as it came in.

DETECTION FACILITIES ON LAND, SHIPS, AND PLANES

Senator HUMPHREY. In your statement on page 2, I just happened to notice in the third paragraph you said:

> We might consider an assemblage of stations spaced over the land area of the earth.

Mr. BROWN. Yes.

Senator HUMPHREY. Are you contemplating inspection stations and inspection facilities only on land areas?

Mr. BROWN. No.

Senator HUMPHREY. That is not to be exclusive, in other words?

Mr. BROWN. I would count an island as being a land area. I'm sorry, perhaps I was not quite clear.

Senator HUMPHREY. It is not possible that you might have detection facilities by ships?

Mr. BROWN. Indeed.

Senator HUMPHREY. And by planes?

Mr. BROWN. As I suggested to Senator Symington, that should be done. One should have a number of ships as well with monitors on them, and perhaps even airplanes.

DISTANCE BETWEEN TESTING STATIONS

Senator HUMPHREY. I want to go just a little further, to get the point clear with reference to the distances between the inspection stations.

Do I undersand it is your view that if we could narrow those distances to about 500 miles, and have them inclusive of the Soviet Union, the detection would be more reliable?

Mr. BROWN. Yes.

Senator HUMPHREY. And you indicate possibly less costly, but the main point is more reliable.

Mr. BROWN. Less costly per station; yes.

YEARLY NUMBER OF EARTHQUAKES

Senator HUMPHREY. How many earthquakes a year, for example, are registered in the Soviet Union land area on the average.

Mr. Brown, I'm sorry, I cannot give you that figure, but on our seismographic stations throughout the world there are approximately annually 1,000 shocks in the energy range in which we are interested.

Senator HUMPHREY. That is averaged out very regularly?

Mr. BROWN. That is correct.

Senator HUMPHREY. Is it your testimony that the closer the test station to the explosion the more accurate the data and therefore the easier to differentiate between an energy explosion such as nuclear energy and an earthquake?

Mr. BROWN. That is correct.

Senator HUMPHREY. Even though there may be great similarity in recordings?

Mr. BROWN. There is, of course, great similarity in recordings. I would like to say that this does not amount to very much in the way of station numbers. If you had a thousand-mile grid, it would mean that over the continental areas you would have somewhat less than a hundred stations worldwide. Over the sea areas you might want an equal number, roughly. Let us say 200 stations altogether.

NUMBER OF INSPECTION STATIONS

Senator HUMPHREY. Mr. Stassen, in his testimony, suggested that in the Soviet Union we might, under international agreement, seek 11 or 12 stations, and Mr. Orear suggested 22. What is your——

Mr. BROWN. I made a rough estimate. I was unfamiliar with these other figures. This is an independent estimate, and I estimated, roughly, in the Soviet Union proper, 10 stations; North America, 10 stations, roughly. It will be that order of magnitude. A group of men far more competent than I would want to look into this in a very detailed manner, I believe, internationally before one reached any conclusions.

EFFECTIVENESS OF TESTING APPARATUS

Senator HUMPHREY. Is it your view that the testing apparatus known today, which is in the possession of our scientific community, as well as of the Soviet Union and our respective Governments, is adequate to locate bomb explosions? I am not talking now only as to measurement of size, yield, fallout, nature, chemical composition, but can you locate?

Mr. BROWN. Yes; you can locate quite well, using seismic techniques. A very fine evidence of that was the work that was done by Professor Bullen in Australia, who pinpointed the exact coordinates of one of our big explosions, including the time elements involved and the magnitude involved, much to the embarrassment of certain agencies.

RELATION OF COMMUNIST CHINA TO TEST SUSPENSION

Senator HUMPHREY. I asked this question because some of us have been concerned in the discussion of disarmament as to whether or not we should enter into any kind of agreement relating to disarmament,

whether it was a piecemeal agreement, an initial-stage agreement, or a package agreement, without including within that negotiation Communist China, which represents a tremendous land mass and a very powerful segment of organized society. Would it be your view, in light of this testimony that you have given, that if bomb tests took place in Communist China, we would be able to ascertain it?

Mr. BROWN. I believe that——

Senator HUMPHREY. May I just interrupt there? We do not recognize China, and, therefore, it would be rather difficult to talk about locating stations in China, unless we had some third party do so under an international arrangement, if the Chinese would do it without exacting a price.

Mr. BROWN. In the initial stages, it is not absolutely necessary to have stations in China, but, in the long run, I think it is absolutely clear that, if we are going to make real progress in this area, China must be a part of the overall network and control system.

Senator HUMPHREY. Wouldn't this be particularly true in reference to underground explosions?

Mr. BROWN. This would be particularly true in reference to underground explosions. One would have to recognize that, even though you would ring China with our modern seismic devices, the distances over which we are operating are so large that your sensitivity would drop down considerably.

IMPORTANCE OF ADVANCE KNOWLEDGE TO TEST DETECTION

Senator HUMPHREY. The Rainier test was a publicized test, was it not?

Mr. BROWN. The Rainier test was a publicized test, where the time of detonation was given.

Senator HUMPHREY. And where the seismologists were notified.

Mr. BROWN. The seismologists were notified at a meeting which I attended in Toronto of the International Geophysical Union.

Senator HUMPHREY. I was wondering whether, in your view, advance knowledge that the test was going to take place, where it was going to take place, and other information concerning the test made it easier for the scientists or the technicians who were trying to verify the reports.

Mr. BROWN. Oh, unquestionably, yes. If you know when the shock takes place, then you know exactly where to look on your chart strip, and there on the chart strip you might see a little hump which you otherwise would not have noticed.

Senator HUMPHREY. So, if you had a large land mass such as Communist China outside the international inspection area and not a party to this agreement, it would be possible to conduct tests with some degree of certainty of not being detected?

Mr. BROWN. Yes.

Senator HUMPHREY. This is a factor that we have to face up to, is it not?

Mr. BROWN. That is certainly a factor that has to be faced up to. In my opinion, in the long run, the kind of network which I described will not be of great long-range value unless it is a worldwide agreement.

WEAKNESSES OF A SOVIET UNION-UNITED STATES AGREEMENT

Senator HUMPHREY. One of the weaknesses that I saw in Mr. Stassen's testimony, from my own viewpoint, after having listened to it and later examining it, was that he contemplated the agreement strictly between the Soviet Union and the United States, and with the possibility always present that either side could transfer weapons to others for test purposes.

I mean it would be possible for the Soviet Union to say that Czechoslovakia had made such advances in weapons, get the Czechs to test them, and disavow any knowledge thereof. It would be possible that the French, who have been working for a long time on nuclear weapons, might say, "We have arrived; we are testing it on our own," even if we shipped it to them. Isn't that a possibility under a limited agreement?

Mr. BROWN. It certainly is; yes.

Senator HUMPHREY. What would be the advantage, then, of a two-power agreement?

Mr. BROWN. The only advantage of a two-power agreement that I can see is that it would get something started, and it would establish networks in those nations which today have the greatest nuclear capabilities. But, in the long run, it would not be terribly valuable and could be outright dangerous.

POSSIBILITY OF U. S. S. R. AGREEMENT TO TWO-POWER AGREEMENT

Senator HUMPHREY. From your reading of the statements which have been made and your study of this question, which, of course, has been very detailed and professional, do you think that the Soviet Union would be willing to agree to a two-party arrangement when one of the other nuclear powers was our NATO ally, Great Britain, and a fourth possibility was France?

Mr. BROWN. I do not know.

Senator HUMPHREY. What is your view? Do you have a view on that? This is a question that comes to my mind. It is only one of opinion.

Mr. BROWN. I believe that the Soviet Union, and here again this is just a view, I believe that it is very much to the interest of the Soviet Union that nuclear technology, from the point of view of military applications, be slowed down in its spread to other countries. It is as much to the Soviet Union's interest as to ours. I believe she would be willing, therefore, to consummate agreement. Whether between just two nations, I don't know.

Senator SYMINGTON. Mr. Chairman, may I ask a question?

Senator HUMPHREY. Please do.

REASONS FOR FAVORING TESTS SUSPENSION

Senator SYMINGTON. I would like to shift a little if I may and ask you this question, Doctor. First, why do you want to see testing stopped? I know you do, but I would like to ask you the question: Why do you?

Mr. BROWN. I would suppose the main reason that I wish to see testing stopped is that today we have got these big bombs hanging

over our heads, and right now there is very little we can do about that. But at least it just involves 2 nations, and, although it is possible that something will happen there, the probabilities are far lower than if you have got 10 or 15. We have all seen examples, even in recent weeks, of irresponsible actions on the military side. With 15 nations in the running, with big bombs in their possession, it would seem to me that nuclear holocaust would be very probable, indeed.

I believe that stopping nuclear testing will slow that down. In addition, although there is great discussion about the dangers resulting from contamination, radioactive contamination of the atmosphere, this is still a debatable point, certainly, but the fact remains that, as more and more nations come into possession of nuclear weapons, as tests continue, the levels of contamination are going to attain considerably higher levels than they are today. This could be very dangerous.

HAZARDS OF FALLOUT

Senator SYMINGTON. Now, my next question has to do with that. Are you worried about the fallout aspect? I am not talking about local fallout, but are you worried about the fallout aspect, primarily, or strontium 90 distributed through plants and vegetable life? Which is the one that you think is dangerous, or do you think both are dangerous?

Mr. BROWN. By both do you mean fallout or military action?

Senator SYMINGTON. No; I mean the fact that we will ultimately suffer as a result of fallout, beyond local fallout, when it comes down from the sky, which I understand may be a long time, perhaps 5 years with a megaton bomb.

Mr. BROWN. Yes.

Senator SYMINGTON. Does that worry you, with your vast knowledge as a geochemist in this field, or are you afraid of what will happen as a result, for example, of strontium 90 being utilized by cattle which we eat or by plants which we eat?

Mr. BROWN. I think that the dangers that have been pinpointed thus far in connection with fallout, the strontium 90 is perhaps the more serious.

Senator SYMINGTON. Out of the air or out of animals and plants?

Mr. BROWN. I think through the cycle of strontium 90 falling on the surface of plants and being ingested by animals and by humans, and entering the body in that way; yes.

Senator SYMINGTON. So that what worries you now is the question of the buildup of troubles and not the fallout itself?

Mr. BROWN. I am worried about both; yes. I would say that my worries in that connection, however, are small compared with the worries involving nuclear holocaust.

Senator SYMINGTON. I thought you were going to say your worries with respect to fallout, based on the records of the Marshall Islanders and so forth, were small as compared with the ultimate troubles incident to, say, strontium 90 in the human body.

Mr. BROWN. That is true, also.

Senator SYMINGTON. I think we are all worried. I was wondering which one of those do you think is the——

Mr. BROWN. At the moment, I would say, from the worldwide point of view, the strontium 90 is the one that we have to worry about most.

But I would like to stress here that we by no means know everything that we ought to know in this area. There is a great deal that we don't know. We don't know as much as we should know.

Senator SYMINGTON. I think one thing we do know is that if we get to tossing these megaton bombs around as a result of another all-out war, then we might completely contaminate the whole world.

Mr. BROWN. Indeed.

Senator SYMINGTON. That is a fair statement from all forms of contamination; is that correct, as you see it?

Mr. BROWN. Yes.

Senator SYMINGTON. Thank you, Mr. Chairman.

EFFECTIVENESS OF DETECTION SYSTEM

Senator HUMPHREY. Proceeding a little further, Dr. Brown, do you believe that we can perfect a test-detection system that is reasonably reliable and, therefore, worthy of the risk that you have indicated we would have to take?

Mr. BROWN. There is practically no question in my mind about that. I believe that, if you were to ask me, I could gather a crew of men together and design a detection system such as I have described in very short order, and it would not be expensive.

DAMAGE TO SURROUNDING AREAS BY UNDERGROUND EXPLOSIONS

Senator HUMPHREY. In reference to the underground explosion, I want to press you a little more on this, because this is one of the most interesting developments and there has been far too little commentary upon it. The University of California Radiation Laboratory made a statement relating to the detonation of September 10, 1957—that is the Rainier explosion—in their publication, and they said as follows:

> From the seismic measurements it was concluded that shots with yields higher than Rainier by at least two orders of magnitude could be safely fired at the Nevada test site.

I think that was a small bomb, 1.7 kilotons. The preceding statement indicates there may be an upper limit to the size of the tests which can be made underground. Do you have any scientific information that indicates that, if you get an underground shot too big, certain forces are set in motion which have danger inherent within them which are uncontrollable?

Mr. BROWN. I would doubt that. I would think the main limitation would be: How far away are people living? The San Francisco earthquake would not have been such a bad earthquake if San Francisco had not been on top of it. Certainly, man has a long way to go before he can pump energy into the ground at levels remotely approaching some of our large earthquakes.

Senator HUMPHREY. In other words, that statement would relate, then, to the damage that might be caused to surrounding areas?

Mr. BROWN. That is true; breaking of windows and things like that.

Senator HUMPHREY. So, it is possible to have rather substantial-sized bombs going into the high-kiloton class?

Mr. BROWN. Underground.

Senator HUMPHREY. Underground, or maybe even a megaton, right?

Mr. BROWN. Oh, yes.

Senator HUMPHREY. Insofar as you know, scientifically, as a manageable explosion; right?

Mr. BROWN. That is correct.

DETECTION OF TESTS CONDUCTED WITHIN CHINA'S BORDERS

Senator HUMPHREY. If that is the case, let's take an area like Tibet. We constantly get these stories of miracles and mystery from this mountainous area that is almost inaccessible. But, obviously, it would not be inaccessible if man determined that he needed to use it for purposes of secrecy. Let's assume that this could be used as a testing ground by either China or the Soviet Union, both of whom might then say they knew nothing about the resulting earth shocks. My questions are these: (1) Could we prove, or could an international inspection service prove, that the earth shocks were nuclear tests?

Mr. BROWN. That would depend, as I said earlier, upon the size, but if, through that whole area, you had a grid such as——

Senator HUMPHREY. Assuming that we do not have a grid, and bearing in mind that China is not a member of the United Nations and not subject to any obligation under its charter, there is little reason to believe testing stations would be permitted inside China's borders when it is not a party to the disarmament agreement.

Would we still be able to detect any tests China may conduct?

Mr. BROWN. Then my guess would be that we would be able to detect with existing facilities and surrounding facilities the larger tests; yes.

Senator HUMPHREY. The larger tests?

Mr. BROWN. And we would be able to distinguish those, if they were sufficiently large, from earthquakes.

You see, the larger tests give a different wave pattern.

Senator HUMPHREY. And we would also be able to ascertain where the tests took place.

Mr. BROWN. If you have records, you see, from several seismographs, you would do exactly the same kind of thing that is done today in our own seismological laboratory at the California Institute of Technology. They get records from not only their own institution, but from other institutions both in this country and in others, and then they triangulate, they find exactly where the detonation, or, in this case, the earthquake, took place and they are able to get not only that, but the depth underground.

Senator HUMPHREY. I surely accept your testimony and have a feeling of agreement with it, but I wanted to bring this matter out because these are questions that are asked in the press, by personal contact, and I thought we ought to get a responsible witness to testify to these matters.

INTERNATIONAL CONTROL OF OUTER SPACE

Now, one final question and we shall conclude, unless there are others. You have made a comment in your March 9 speech, Dr. Brown, as follows:

As a start, it should be possible to place the region outside the earth's atmosphere under United Nations' jurisdiction and to establish a system whereby a

satellite could be launched only with U. N. approval following inspection to ascertain its function.

This, of course, presumes and assumes that we could get agreement in the U. N. with both the Soviet Union and ourselves as participating members within the terms of the agreement for outer-space control.

Mr. BROWN. Yes.

Senator HUMPHREY. At the moment, that doesn't look too fortuitous a prospect; does it?

Mr. BROWN. At the moment; no.

Senator HUMPHREY. But we can hope, at least.

Mr. BROWN. But from the technological point of view, it represents a relatively simple kind of agreement.

INSPECTION SYSTEM TO INSURE COMPLIANCE

Senator HUMPHREY. What kind of an inspection system would you envision that would be necessary to insure that satellites were launched only after United Nations' inspection or only after United Nations' agreement?

Mr. BROWN. Here, sir, I would visualize the network of nuclear detection centers as being expanded and as being amplified from the point of view of the kinds of equipment that they had available so that tracking could be done, so that photographs could be made, so that those kinds of missile detection devices that are now available could be applied on a grid basis.

Senator HUMPHREY. In other words, modification of your inspection system to include missile-detection devices.

Mr. BROWN. That is right. I would start off small and then work up.

Senator HUMPHREY. This may be theoretically possible, Dr. Brown, but is it practical? Is it within the next 2 or 3 years practical?

Mr. BROWN. The establishment of a nuclear-detection system?

Senator HUMPHREY. No, I think on the nuclear, we accepted there is a possibility of that.

Mr. BROWN. On the basis of everything I hear, on an unclassified basis concerning the approaches to the problem of missile detection, from the purely technological point of view, I believe that this would feasible; yes.

OFFICIAL RECOGNITION OF MARCH 9 SPEECH

Senator HUMPHREY. Since your March 9 speech, have you been called in for consultation by the Atomic Energy Commission or by other agencies of Government engaged in the matter of perfecting a system of inspection and testing?

Mr. BROWN. I have not, sir.

Senator HUMPHREY. You have not?

Mr. BROWN. No.

Senator HUMPHREY. Either by CIA, AEC, or Defense?

Mr. BROWN. No.

Senator HUMPHREY. Your speech of March 9 has had public comment, but not public official note; is that right?

Mr. BROWN. Correct.

Senator HUMPHREY. I am rather surprised. It seems to me that a speech of that importance which aroused such interest, should have been taken note of officially.

Senator Symington.

DISAGREEMENT AMONG SCIENTISTS

Senator SYMINGTON. I would just like to enlarge on that a minute, Mr. Chairman. Some way, on this committee, we have to see that information we get from intelligent sources, both classified sources and unclassified, is reconciled, so that we know what we are going to do. As I understand it, if there is an agreement, it will probably come before the Senate in some form of international treaty, and certainly we want to know as much as we can before we vote on a subject of this importance.

In this connection, I have been trying ot find out as much as I could about this subject. I have read the debate between Dr. Pauling and Dr. Teller, and I have read your comments and I have read the disagreements between Dr. Fowler, of Washington University, and Dr. Teller, and I have also read Dr. Teller's book and Dr. Latter's Our Nuclear Future.

How is it, do you think, that people, all of whom have the best interests of the United States at heart, all of whom see the dangers of not controlling this steadily developing nuclear-weapon picture, all of whom want to control that picture on some basis which is not from our standpoint unilateral disarmament, how is it there can be such major disagreements between good Americans in the scientific field? That is hard for me to understand.

Mr. BROWN. Well, I think that one thing that all nonscientists should recognize is that scientists are human beings who are subject to all the frailties to which the flesh is heir.

Senator SYMINGTON. But 2 and 2 is still 4; isn't it?

Mr. BROWN. Two and 2 is 4, as long as you stay in the field of mathematics.

Senator SYMINGTON. Isn't nuclear physics primarily a mathematical field?

Mr. BROWN. We are not dealing here solely with nuclear physics, however.

Senator SYMINGTON. I wish you would expand on what your thought is there.

Mr. BROWN. Well, for example, I mentioned that present persons who are heavily involved in the whole area of weapons development, have a philosophy. They are concerned about what they are doing. They want to get the job done, and I think in doing that, some of them frequently don't take the broader view of the situation.

Senator SYMINGTON. What do you mean? Would you define your term, "broader view"?

Mr. BROWN. Well, for example, they neglect to ask themselves what is the ultimate end result, or what might the ultimate end result of our present policy be? They are assigned the job of, let us say, defending us from missiles, which means they want to develop antimissile missiles with nuclear warheads, and this is the approach to do it, of course.

Now, in order to develop these, they have to test; that is the next step. So, anything that might deprive them of the ability of testing, they fight against. Now, in the process of fighting against it, you can take any number; I don't care what that number is, and if you want to make it look large, you can make it look large. If you want to make it look small, you can make it look small.

Senator SYMINGTON. Are you talking about the results of testing?

Mr. BROWN For example, during the big fallout arguments, people play with the same numbers. One will express the fallout results which make them look very, very large. The other side will express the fallout in numbers which make them look——

Senator SYMINGTON. When you say "express the fallout," do you mean the maximum fallout in the Marshall Islands, which we know, and we think we know on that Japanese ship? Are you talking about that kind of fallout? Do you disagree with those figures?

Mr. BROWN. I am speaking now about, let us say, effects of strontium 90.

Senator SYMINGTON. I see.

Mr. BROWN. How much strontium 90 is falling? Well, we know roughly how much is falling.

Senator SYMINGTON. But we won't know for some time, based on the half life, as to what it will or will not do; is that your point?

Mr. BROWN. That is correct.

Senator SYMINGTON. And you go on the pessimistic side?

Mr. BROWN. I tend to; yes.

Senator SYMINGTON. I am impressed with that. Now, here is our problem. When I was on the other side of the Government, I watched it with fascination, but I didn't know much about it. There were a good many people who wanted to stop the development of the hydrogen bomb, and there were a good many people who didn't, and it was very close, in my opinion, because there were fine, patriotic people on both sides. I think we will agree it is well now we don't find ourselves in a position where the Soviet Union has that type of bomb and we do not. Wouldn't you agree with that?

Mr. BROWN. I certainly would agree with that; yes.

Senator SYMINGTON. If we make a mistake in this effort to control testing, it might be the last mistake we are ever permitted to make as free people. That is what has me worried, more than anything else, although I am very happy that Senator Humphrey, with his typical energy, is trying to find a way that we can control testing.

But we have to be sure we don't enter an arrangement where we could find ourselves in the same type and character of position that we might have been in before; don't you agree?

Mr. BROWN. I would agree with that. It is very clear that the decision that confronts us today involves the balancing of two risks, and, no matter how you look at it, no matter what decision you make, there is an element of risk in it. I am convinced, myself, as I have said, that the risks involved in stopping testing in a controlled manner, such as I have outlined, are very small compared with the risks of pursuing the status quo.

Senator SYMINGTON. And, of course, specifically, that is the basic big difference between your thinking and that of Dr. Teller.

Mr. BROWN. That is it; yes.

Senator SYMINGTON. Mr. Chairman, I have no further questions. I want to thank Dr. Brown for his frankness. I again hope that we can get the classified testimony that we received on this, and have Dr. Brown go over it and see what the committee thinks, based on his opinion after he sees that testimony.

CONCLUDING REMARKS OF THE CHAIRMAN

Senator HUMPHREY. We will do our best to do so. I just would like to say to you, Dr. Brown, before you leave us, I associate myself with the expression of gratitude and appreciation of Senator Symington. We have a great respect for your professional knowledge, scientific accomplishments, and services to the country.

The decisions that are made in this area will be made not on the basis of science alone, as you have indicated, but the great overall political values and judgments that must be made. And, while the role of the scientists is a tremendously important role in being able to give to us the exact information as to the reliability of detection facilities or inspection apparatus, ultimately the decision is a political decision.

I mean the kind of a world in which you want to live and the kind of political policies that we will evolve and effectuate. It is at this level that the National Security Council, the President, the Secretary of State, and the Secretary of Defense come in—but essentially, the President, who is the Executive and the Commander in Chief.

What we are trying to do in this committee, and we think we are making a little progress toward it, is to get out into the open as much as it is possible, a candid, frank, intelligent, and intelligible discussion of the ways and the means of inspection and detection, to get the public aware of it, both as to its efficacy and its limitations, and to get the Congress aware of it. As Senator Symington said, if anything is done, we undoubtedly will at least be called upon in the Senate for ratification or rejection.

We will at least be called upon to be concerned about it. So we are, for the first time, I think, getting really down-to-earth, solid information as to what we can expect if agreement were arrived at.

You see, I have been concerned. On the one hand, I hear responsible people say you can't inspect, and inspect reliably.

On the other hand, the statesmen of our country, the political leaders, are indicating that they want an agreement with inspection. You know once in a while you wonder if there isn't a contradiction here. So we might set the record straight, the fact is that those who are the responsible political leaders, the President and his Cabinet and the Security Council, make the decision which relates to evaluating the risks that you have talked about—the risks of an uncontrolled nuclear race, the risks of the fallibility and the limitations of detection and inspection—and they add this altogether in terms of the total world picture, the attitude of other nations toward us, our foreign policy, our security, and they have to come to a judgment and a decision. I think that the best way to get that is the way we are doing it right now, talk about it out in the open.

I surely concur with Senator Symington that we need to get the material that has been placed before us in a sense that is classified at least before a man of your competence and your unquestioned loyalty

and integrity so that we can get the benefit of your advice, because we are laymen. Senator Symington has a distinct advantage in this being on the Armed Services Committee and a former Secretary of the Air Force on the National Security Council. Very few members of the Senate have had that privilege. But some of us who have not had that privilege are going to have the same vote he has, so we have to know a little more.

Senator SYMINGTON. I do not think I have any advantage over the chairman, but I do think our problem is to get the facts out so that we understand them and the people understand them, because public opinion is going to decide this issue, and the public must weigh the risks involved.

Senator HUMPHREY. I am also of the opinion, Dr. Brown, that before we are through there will be one of these conferences in which this will be decided and we had better know what we are deciding.

Thank you very much.

(Whereupon, at 5 : 30 p. m., the committee adjourned.)

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CONTROL AND REDUCTION OF ARMAMENTS

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HEARING

BEFORE A

SUBCOMMITTEE OF THE COMMITTEE ON FOREIGN RELATIONS UNITED STATES SENATE

EIGHTY-FIFTH CONGRESS

SECOND SESSION

(Pursuant to S. Res. 93, S. Res. 185, and S. Res. 286, 84th Cong., S. Res. 61, and S. Res. 241, 85th Cong.)

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NOTE.—Sections of this hearing have been deleted in the interest of national security. Deleted material is indicated by the notation "[deleted]."

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CONTROL AND REDUCTION OF ARMAMENTS

WEDNESDAY, APRIL 16, 1958

UNITED STATES SENATE,
SUBCOMMITTEE ON DISARMAMENT OF THE
COMMITTEE ON FOREIGN RELATIONS,
Washington, D. C.

The subcommittee met, pursuant to call, at 2:05 o'clock p. m., in Room 457, Senate Office Building, Senator Hubert H. Humphrey (Chairman of the subcommittee) presiding.

Present: Senators Humphrey, Sparkman, and Symington.

Also present: Senator Clinton Anderson of New Mexico.

INTRODUCTORY REMARKS OF THE CHAIRMAN

Senator HUMPHREY. I call the meeting to order. I am going to say to our very distinguished witness that it would be very helpful if you would speak up good and loud, because I understand that the microphones before us are for the purposes of radio and not for the purposes of the public address system. The same, of course, will apply to our colleagues here.

I want to welcome to the subcommittee's hearing this afternoon, first Dr. Teller, and then our esteemed and respected colleague from New Mexico, Senator Clinton Anderson.

Senator Anderson's work in the field of atomic energy has earned for him the enviable and justified reputation for genuine statesmanship and patriotic duty.

Senator Symington is here with us and other members will come in. I mention this because we have a bill before the Senate and we are trying to sandwich in a hearing in the meantime.

Today's hearing is one of a series which is being held by the Senate Subcommittee on Disarmament. Our hearings have been devoted to evaluating various proposals designed to achieve some reduction and control of armaments. The assignment given to this subcommittee is a formidable one, and we are very conscious of it.

Each year the nations of the world spend over one hundred billion dollars for armaments. The cost of the arms race is increasing rather than decreasing. The weapons being devised are becoming more costly, more efficient and in many cases more destructive.

The question before this subcommittee, and indeed before all the people, is: are there ways to halt or slow down this race in armaments, ways which will not jeopardize our national security and the security of the many nations throughout the free world allied with us?

The disarmament subcommittee has been exploring the problem of arms control for almost 3 years. We have not come up with utopian plans or air-tight answers. We have, however, tried to narrow our

studies to those arms control proposals which merit serious consideration by the United States and other nations. Today our hearing will deal primarily with two such proposals. One is a proposal for an international agreement to suspend nuclear weapons tests with an international inspection system to assure that the suspension is observed.

I underscore that this subcommittee has at all times had before it and supported the concept of international inspection and detection.

The second is a proposal to suspend or cease production of fissionable materials for weapons' purposes with an inspection system to verify that such a cutoff is carried out.

Both of these proposals have been made by the President of the United States and his principal advisers. But these proposals have always been tied together as part of a disarmament package. The President has not yet suggested that these proposals should be separated with the view to obtaining international agreement on one or the other, rather than both.

It should be noted and emphasized that this subcommittee has at all times pointed out and stressed the importance of an effective international inspection and detection system. We have spent much time looking into how this could best be accomplished. Speaking for myself, I have not favored unilateral disarmament measures with the hope that by setting an example we would persuade others to do likewise. Nor have I subscribed to unilateral cessation of weapons tests without inspection. The central issue is: can we negotiate a beginning in disarmament that includes effective inspection and detection?

The President has stated repeatedly that we are prepared to negotiate a disarmament agreement that includes inspection. So, the administration supports the principle of inspection in any disarmament agreement. Nevertheless, there are those who have expressed serious doubt as to whether or not an inspection system could work and would be safe.

This subcommittee released testimony yesterday from responsible officials of our Government that casts doubt upon the possibility of an effective inspection system.

It is because of these differences of opinion that the subcommittee seeks further information, for the Congress and the people. These hearings form an essential part of that search.

The subcommittee's witnesses today have been asked to give their views primarily on various aspects of the proposal to suspend nuclear weapons tests, and particularly on the type of inspection system which in their view would be required to verify the suspension. The subcommittee, however, does not wish to restrict the witnesses, and welcomes suggestions and views on any matter related to the broad disarmament problem.

INTRODUCTION OF FIRST WITNESS

Our first witness is Dr. Edward Teller, one of the world's leading nuclear scientists, and we are very grateful to you, doctor, for being willing to come here in public session. He is the new director of the University of California Radiation Laboratory at Livermore. He has contributed greatly to the various programs of the Atomic Energy

Commission. He is highly regarded and respected throughout our Nation.

Recently Life magazine carried a feature story on Dr. Teller's latest book, Our Nuclear Future, which subsequently has been published. In this book, Dr. Teller makes a persuasive case for the need for continued nuclear tests. The views expressed by Dr. Teller in this book and elsewhere have been the subject of extensive discussion.

It is the feeling of this subcommittee that Dr. Teller's prominence in the field of science warrants that he be afforded every opportunity to give us the benefit of his views on this tremendously important problem.

We are pleased to have him appear before us this afternoon in public session. I should like to add, however, that if there are questions addressed to Dr. Teller, which he can answer frankly only in executive session, the subcommittee will go into closed session following the conclusion of the public hearing.

I would like to request of Dr. Teller that in this public session he be as frank and candid as he thinks possible in his public testimony.

Dr. Teller, I want to assure you that despite any views that any one may have, the subcommittee has not arrived at any conclusion relating to the suspension of tests under inspection. We are still seeking information. We welcome the thoughtful observations of men of your great talent, experience, and knowledge. I am sure that I speak for every member of the committee, and with that, unless my colleagues have something they would like to add, I am going to suggest that Dr. Teller proceed. It is his desire that he complete his statement and then we can ask him questions. It may help the continuity of his testimony.

Is that your desire, doctor?

Dr. TELLER. Thank you, Mr. Chairman.

STATEMENT OF DR. EDWARD TELLER, DIRECTOR UNIVERSITY OF CALIFORNIA RADIATION LABORATORY, LIVERMORE, CALIFORNIA

Dr. TELLER. Thank you very much for your kind words. I will try not to abuse your patience. It is a particularly great pleasure for me, a great privilege, to be allowed to appear before your subcommittee.

What you are seeking is a road toward lasting peace. My earliest memory is that of a devastating war, the First World War, which tore up my native country, Hungary, in the wake of which Fascist dictatorship has arisen, and if there is anything I would like to work for, it is peace.

EXTENT OF DISAGREEMENT ON THE POSSIBILITY OF HIDING TESTS

Let me please say that there has been a lot of discussion and a lot of publicity about the point that there is a disagreement whether or not tests can be hidden.

Am I talking loudly enough?

Senator HUMPHREY. Thank you. I am going to ask the room to be very quiet. This is very important testimony.

Dr. TELLER. I believe that among the people who are aware of the relevant facts (and the main points are public knowledge) among the people who are aware of these facts, there is no disagreement as to these facts.

DEFICIENCIES IN OUR KNOWLEDGE ON TECHNICAL POINTS OF HIDING TESTS

Our knowledge about a great number of technical points is incomplete, and there differences of opinion naturally exist. I would like to say, however, as part of the general background that there is a certain lack of balance in our knowledge.

For years there has been diligent and excellent work on the question how to detect tests. We were vitally interested in tests going on everywhere, and so the methods of detection have been developed.

Except for a little work in the last few months, there has not been work on the question how to hide tests. Therefore, our knowledge of hiding tests is deficient. Even so, even matching this deficient knowledge against a well worked out system of detection, we already see strong possibilities, effective possibilities of hiding tests, and it is to this question as it stands now that I should first like to address myself.

POSSIBLE DETECTION OF BIG AND SMALL EXPLOSIONS

I said there is agreement. There is agreement on this. Small tests, tests of small explosions, can be hidden. Tests of big explosions can not, as we stand today.

This may change in the course of time.

Now, I will not say what I call a small explosion and what I call a big explosion. About that, there is a little disagreement as there is apt to be. The disagreement is not great. For our purposes, it will be more important to say, more informative and understandable to say what can be accomplished by those small tests which can be hidden.

IMPORTANCE OF SMALL TESTS

First of all, these small tests are important in themselves because the weapons they test can perform exceedingly important roles in many military situations. I should like to come to talk about that later.

Second, by making small tests, one can learn a very great deal about big explosions. With the help of small tests, one can improve one's big weapons.

This does not mean that big tests are unnecessary. But it does mean that if there is a test cessation, and one party uses the possibility of testing small explosions in secret, and the other party does not, then the violator will have gained a great advantage not only in the field of small weapons but in the field of the big weapons as well.

Thirdly, by testing small explosions, one is learning more and more about the way how bigger explosions can be hidden.

Now, let me clear up one point here. May I continue?

Senator HUMPHREY. Please do.

UNDERGROUND TESTS: A METHOD OF HIDING

Dr. TELLER. To hide small explosions does not mean to perform them in such a way that nobody can notice them, at least not necessarily so. There is particularly one method of hiding which has been quite generally discussed, and that is to hide a test by putting it underground. No radioactivity whatsoever escapes. But there is an earthquake signal.

Now the crust of our earth is an exceedingly noisy place. There are many thousands of earthquakes throughout the surface of the globe each year with which a small nuclear explosion can be confused. The question is how to make the signal from a nuclear explosion small enough and, if possible, how to make it similar enough, to a signal from an earthquake.

Now, this is a highly technical subject, but the main thing about it is that it is a subject about which our knowledge is very poor. What an earthquake is, what is the cause, what is the starting point of an earthquake, slipping of layers, or whatever, is not known in detail. What a nuclear explosion underground will do, we know from one and only one shot, and a smaller shot at that.

DANGER OF COMPARING FACTS ABOUT EARTHQUAKES WITH INFORMATION FROM A SINGLE NUCLEAR EXPLOSION

If we had not performed this one shot, we would compare the known facts about earthquakes with a complete vacuum of knowledge.

Now, we are extrapolating from a single event which we know well. This is an extremely dangerous situation.

We need lots more information upon this subject. If we go into a test moratorium, with deficient knowledge, and if thereupon we do not continue to test, but the Russians experiment with small nuclear explosions which we know can be hidden, then by their experimentation, they may find out a great deal. I think they will find out more and more and clearer and clearer methods how to make these explosions disappear among the many earthquakes which occur spontaneously. A great deal can be done by hiding tests in this manner, because it is a scientific question that as yet has been hardly attacked at all.

OTHER POSSIBLE METHODS OF HIDING TESTS

Now, there are many other methods how to try and hide tests. And it would be a mistake to think underground tests are the only means of evasion. It is wrong to think that a net of seismic stations in the Soviet Union will make us safe. There are all kinds of other ways how a test moratorium could be circumvented.

I would not like to go into this question because the subject is infinite. I should just like to assure you that the thinking along these lines has just started.

RELIABILITY OF AN INSPECTION SYSTEM

I would like to say that there is, in my opinion one reliable way how to check a test moratorium, and that is the human way.

If our people could get into Russia in any numbers, if they could go to any place, if they could talk to anybody, if also we would be sure

that Russians, Russian scientists who repeatedly talk with our people will not suffer because they have talked, then I think we could learn about tests. We could find out from the many people who are involved in a nuclear test.

This would mean an opening up of Russia, and this would in itself be a really wonderful thing. About that possibility, I would only say that if it is a real one, I am all for exploring it. But the country must be really open and we should realize that our own country is absolutely open, and that even if Russia should open up to the greatest extent we can now imagine, we still would have our wonderful institutions of which we are justly proud, like the institution of a free press, which will make it for us forever impossible to do anything but abide most strictly by any agreement which we have undertaken.

Russia will have to open up a very great deal to begin to match that.

LIMITATION OF TESTS TO UNDERGROUND

Now, I should like to discuss other possibilities of checking, of having agreements that can be checked. These possibilities are more realistic for the near future than the opening up of Russia.

There is the possibility of having an agreement that future tests will be only underground, so that no radioactivity will be released into the atmosphere and so that the radioactivity underground will be contained in places where it could not contaminate anything that gets into contact with human beings.

Such an agreement would have the advantage that it could be enforced. Radioactivity released into the atmosphere can be noticed easily. Therefore, one can indeed see if no radioactivity or no substantial radioactivity is released.

This agreement also has a consequence in respect to the radioactive fallout. This fallout, then, would no longer continue to increase as it would if testing should continue.

DANGER OF RADIOACTIVE FALLOUT

Now, I have said and I maintain that the danger from radioactive fallout has been very, very greatly exaggerated. I maintain that our test procedures have been safe with the exception of one accident in the Pacific. Apart from the very regrettable accident in the Pacific, we have been successful.

I know that the radioactivity which we have released is quite small compared to the natural background with which we are familiar and about which we never have been worried.

Still, in spite of all this, I would like to agree to one thing. Fallout, however unjustified, has caused a great deal of worry, a great deal of anxiety. Simply in order to quiet this anxiety it would be good not to add any more to the fallout if this can be done without endangering our national security.

DISADVANTAGES OF UNDERGROUND TESTING

I think this could be achieved by underground testing. But it would restrict many things which we should not restrict.

It would restrict some of the peaceful applications of nuclear explosions about which I shall talk later.

It would hold back some of our defensive measures like our work on the very difficult project, the most difficult and doubtful project of the anti-ICBM.

I think that for these reasons a limitation to underground testing would have quite serious consequences. It would have the advantages which I have mentioned.

PERMISSIVE SURFACE AND ATMOSPHERIC TESTS OF "CLEAN" EXPLOSIVES

There is another possibility, and I would like to talk about that for a little while: That is to limit tests to underground explosions and to such further surface tests or atmospheric tests which are performed with cleaner and cleaner explosives, or at any rate with small explosives so that the further additions to the radioactive fallout should be quite small compared to the radioactive content of the present atmosphere.

In other words, the past tests have given rise to activity which is small compared to the natural activity. I now say that we could so behave as to add further to this only a negligible amount so that it should be negligible even as compared to the amount present now which in turn is negligible compared to the natural radioactivities.

This kind of a limitation would be a little harder to check. However, we have made progress in that field. Our President has announced early last summer that a big clean explosion will be demonstrated. He has restated our intention to do so a few weeks ago. We are working on that, and by demonstrating a clean explosion, the cleanness of an explosion, we have made and we are making the first step toward an inspection system. Big explosions might be registered with the United Nations and then these big explosions would have to be checked by inspection teams such as the teams which we are now planning for next summer. These teams could then testify to the cleanliness or to the degree of cleanliness of this particular explosion.

NEED FOR INSPECTION TEAMS AT BIG EXPLOSIONS

This would have the consequence that there would have to be inspection teams at any big explosion, and the existence of these inspection teams would be a cooperative venture in which the Russians and ourselves and the British could participate to insure the world against future big additions to the contamination.

Furthermore big explosions are relatively easy to produce in a dirty form. They are much harder to produce in a clean form. An international agreement prohibiting big dirty explosions will make it more difficult for additional nations to find out how to make any big explosions. This may be in the interests of both the Russians and ourselves.

Therefore, I can see some very considerable advantages to a proposal of this kind.

DISADVANTAGE OF PERMISSIVE SURFACE AND ATMOSPHERIC TESTS OF "CLEAN" EXPLOSIVES

On the other hand, it would slow us down with some of our defense efforts. It would not slow down the peaceful use as far as I can see.

Therefore, I say that this possibility, too, has a pro and con. It

is a difficult question involving bargaining with the Russians, involving military considerations, involving political considerations, involving propaganda, and I do not feel competent to make a definite proposal.

But I would say this scheme is worthy of serious consideration.

CUT-OFF OF PRODUCTION OF FISSIONABLE MATERIAL FOR WEAPONS PURPOSES

Now, I should like to come to the next question which has been raised in the opening statement of the chairman, the question of limiting and checking production.

I should like to say about that quite briefly that I believe that to limit production and check this limitation is as difficult, and it may be more difficult, than to check tests.

I should say that this, too, will require essentially an openness of the country and an openness of access, which is very, very foreign to the present practices in Soviet Russia.

INSPECTION OF STOCKPILES

Finally, I would like to discuss the checking of stockpiles, to the idea that the stockpiles in the long run might diminish and eventually vanish. To that I would like to say that this is the most difficult of all.

Stockpiles can be so easily hidden that I believe that this is really practically impossible.

Senator HUMPHREY. Were you saying that the inspection of the limitation on production of nuclear materials was impossible?

Dr. TELLER. I said that checking on the limitations on nuclear production is very difficult and requires an open country. I said that the checking of weapons in stockpiles is practically impossible. This is a separate statement, separate from production.

PURPOSE OF ADDITIONAL AND MORE EFFECTIVE NUCLEAR EXPLOSIVES

Now, I believe that the stopping of tests and the stopping of production will limit us in the number and quality of our weapons. But why should one want more weapons and better weapons when our power of destruction is already incredible in its size?

Well, this is a military question, and I am not a military expert. I am out of my field. I have, however, worked with nuclear explosives, lived with them for some time, and I have some statements to make which I think may be relevant.

NUCLEAR WEAPONS FOR DEFENSIVE PURPOSES

First of all, it is our policy to concede to the Russians the first blow in any big engagement. That puts them naturally in a very advantageous position. Attack is easier than defense.

A city is easy to attack. A nuclear machine, a military machine such as a fast-flying object, is much more difficult to destroy. It is for the purpose of this defense that we need the great numbers of nuclear explosives and the excellence of the nuclear explosives toward which we are striving. But this is not all.

We have in the past thought of preserving the peace by the threat of massive retaliation. As the Russians acquire (and they have acquired), the ability of massively attacking us, the possibility of our massive retaliation is looking more and more unrealistic. If the Russians commit limited aggression it will be hard and in my opinion, it would be wrong to answer by massive retaliation and to provoke an allout war.

Therefore, we must have a method to defend our allies by methods short of massive retaliation.

I believe that the only way to do this is to possess weapons which are wholly mobile, which we can take to any endangered point in a matter of hours.

POSSIBILITY OF LIMITED WAR

I believe that a limited war is a possible war. I hope that it will never come, but if there is a Russian attack, we have to strive to keep the war limited, and I think that it can be kept limited because it is not in our interest and not in the Russian interest to make an allout exchange of it.

By limited, I do not mean that in a small war only small weapons be used. I mean that in any war, the right weapons be used, and the war should be limited not by limiting the size of weapons but by limiting ourselves to destroy the attacking army, the attacking war machine. In the process we must try to avoid as far as possible to hurt the innocent bystanders.

This is not an easy thing and never has been an easy thing. I think that it is entirely possible to help our allies to defend themselves, to destroy with the help of appropriate nuclear explosions any big and expensive war machines and enemy concentrations, and thereby make it possible for guerrillas who are defending their own country to attack and destroy the enemy which will have been forced into dispersion.

NUCLEAR WEAPONS AS A DETERRENT TO MASSIVE ATTACK

In other words, I believe that it is only the massive attack against which a courageous and determined people would be helpless, and it is precisely the massive attack which we can frustrate with our nuclear weapons.

In this sense, nuclear weapons can become and should become real defensive weapons. We can further defend our allies by the certainty that an attack upon them by the Soviet Union or by a Communist country will be met with strong counter measures. Under these conditions I think we can insure our allies against an attack.

EFFECT OF A CESSATION OF NUCLEAR TESTS UPON DEVELOPMENT OF NONRADIOACTIVE WEAPONS

Now, in order to do this, we have to develop something which is hard to develop, and that is clean weapons. Radioactive fallout in tests has an exceedingly small importance. I should be glad to expand on this in questions if that be necessary. But in a nuclear war, the radioactive fallout can have and I think will have devastating consequences.

We must have the clean weapons to save the innocent bystander, to save our allies and, when we defend ourselves against any enemy attack, to save our own people. We must have these clean weapons and stoppage of nuclear tests would prevent us effectively from developing them.

By trying to be supercautious now, we may unnecessarily sacrifice millions of human lives in a dirty nuclear war later.

PEACEFUL USES OF NUCLEAR EXPLOSIVES

Clean weapons also play an exceedingly important role in any nonmilitary use of nuclear explosives. You have heard about these nonmilitary uses. You have heard about the possibility of earth moving jobs, like making harbors. Nuclear explosions could become useful in mining, in oil production, in improving the water supply situation. In many of these applications, it is important to have clean explosives. There is even the possibility to have underground explosions in a cavity which can produce steam.

Now, in order to do all that, we need hydrogen explosives because only the hydrogen explosive is a really cheap supply of energy. In this way, fusion energy could be made to serve peaceful purposes at a relatively early date. I am not sure that this can be done, but there is real hope.

It is remarkable that the hydrogen bombs which have been quite a few years ago denounced as good for nothing but to destroy cities are now turning out to be important for defense, important for clean weapons, important for clean explosives, for peaceful purposes, and even important for power production.

It is a usual development that some new source of power should become first really significant in its military applications. When chemical energy was released as Greek fire, as gunpowder, this was military use. Later this energy has been turned to peaceful purposes.

If we stop experimentation with nuclear explosions now, we are stopping at a place where we know how to use nuclear explosives in order to destroy, but where we do not know how to use nuclear explosives in order to improve man's living.

NUCLEAR EXPLOSIONS UNDER INTERNATIONAL INSPECTION

It has been suggested that the peaceful nuclear explosions should go on under international inspection. This is an extremely difficult thing to do. Let me talk about it for a moment.

First of all, you might say: here is an explosive, we are going to use it and it will dig a harbor or a canal. It is peaceful. Sure, we can do it, but how do I know what is in that explosive. It may be something that is used for peaceful purposes, but at the same time it also may test a new principle which could be used in a military way.

In order to have an effective international inspection, it is necessary not only to have the explosion inspected, but to open up the explosive, look into it and see that it is an ordinary type of nuclear explosive. This could be done, but it certainly would give away a lot of information which at present is kept very closely guarded.

Furthermore, the most important applications of nonmilitary use require clean nuclear explosions. Clean nuclear explosions are those

which are at the growing tip of our development, and so such international inspection would in actual fact disclose practically everything we know about nuclear weapons to the outside world.

Now, I am not arguing against it. If peaceful uses can be developed (and I think they can be developed), they should be used for the benefit of mankind. But this does not necessarily mean that we should place the knowledge and the means to produce nuclear explosions indiscriminately into the hands of everybody.

This is a very big step and it would be a complete reversal of our thinking. Such a change cannot be undertaken without most careful consideration. I should say, therefore, that international inspection, complete and effective inspection, of all peaceful explosions will mean a complete reversal in our policy of keeping nuclear explosives to as few nations as possible. We should go into it very slowly and considerately, if we go into it at all.

RELATIVE EFFECT OF TEST SUSPENSION UPON THE U. S. S. R. AND THE U. S.

Now, I should like briefly to ask the question: if, in spite of everything I said, the Russians and we, would stop nuclear testing, where would that leave us?

Well, let me start by saying that I believe that the Russians are developing their war machine faster than we are.

Sputnik has wakened us up to this fact, but it seems to me that we are going to sleep again, and the Russians are gaining on us with each passing month.

There is one area and one area only where I dare to hope (I don't know, but I dare to hope), that we are still ahead of the Russians. Our knowledge is incomplete, but there is a hope that in the nuclear field we are still ahead.

If both of us would stop nuclear tests, then there is no doubt that through espionage the Russians would find out sooner or later what we know, and then we would have lost our last advantage. We can stay ahead only by moving ahead. But there is more to it.

EFFECT OF TEST SUSPENSION UPON EVEN LIMITED USE OF NUCLEAR EXPLOSIVES

If we stop nuclear tests, then we have made a further step in the direction of making the use of nuclear explosives very difficult and virtually impossible even in a limited way. This would leave the nonnuclear war machine of Russia free to take over the countries on the periphery of the Communist empire. I am sure that under those conditions Russia would, or rather the Communists would, conquer the world slice by thin slice and we could not do anything about it.

DANGERS OF UNILATERAL TEST SUSPENSION BY THE UNITED STATES

Now, let us look at the more dangerous, and the quite probable alternative, that we stop nuclear tests, but the Russians carry on some nuclear testing, first small nuclear tests and then maybe bigger ones. Under those conditions they may develop the clean explosives which we do not develop. Some day, 5 years from now, 10 years from now,

may the Russians announce, "We have clean explosives with which we can serve the good of mankind."

They would thereby achieve a greater victory than sputnik and a successful economic offensive put together.

At the same time, they would put enormous pressure on everybody, and also on the United States, because they would have shown that they are way ahead of us in nuclear technology for the purposes of war as well.

Imagine the situation where the Russians use clean nuclear explosives in a limited war and where they say that the capitalist nuclear explosives are all dirty and kill the people.

We would have no way of replying, and we would stand by completely helpless.

Mr. Chairman, this concludes that part of my prepared testimony that deals with objective matters. I should like to ask you to be patient with me for a few more minutes, because I would like to make a personal remark which will show, perhaps, a little bit my motivation, why I am saying what I am saying.

Senator HUMPHREY. Go right ahead, sir.

CONCLUDING REMARKS

Dr. TELLER. Any person who has been worrying as I have for many years about nuclear explosives has asked himself the question what about the possibility of preventive war.

Now, somebody may make the assumption that whoever starts an allout nuclear war, wins it.

Somebody may make the assumption that the Russians will start it sooner or later. It may appear as a mathematical certainty that we must strike the first blow or else die.

Even if that mathematical certainty were demonstrated, even then I would say we must never, absolutely never, strike the first blow. There is nothing to which I would be more definitely opposed as preventive war, and this is the main reason why I believe that we must stay strong in the nuclear field as well as in other fields.

Now, it has been claimed, and it is true, that we live in a dangerous world. Banning nuclear tests will not make our world any less dangerous. The dangers from Russia, I have outlined. They are not the only dangers.

Any dictatorship that has enough control over its people will be able to develop nuclear weapons secretly. By a nuclear ban, we will penalize the open countries, the democracies, and we shall strengthen the Nassers, the Perons, the dictators all over the world.

The development of technology in the last years has made weapons more dangerous. It also has made them smaller, more easy to hide, has put surprise into development which we cannot counter by anything except by openness. Future secret weapons cannot even be guessed at, so how can they be checked?

Inspection of disarmament is becoming more difficult every year no matter what we do about it. But there is another way to peace. That other way is to remove the causes of war. The world is becoming a smaller and smaller place. We are living closer and closer to each other, and we are interdependent. I have given you the example of

peaceful nuclear explosions. This is but one example. There are many miracles of technology which could contribute to better living and to a diminishing of tension.

We could cooperate with many people, even with the Russians. I hope we shall cooperate with the Russians, in the long run in positive enterprises, and I think we should do it as fast as we possibly can.

These measures are the real builders of peace, and these measures are the really important things. But in order to construct a world which is peaceful and lawful, a world in which we can live side by side, a world in which we must be our brother's keeper, in which we cannot turn our back to any body, and in which we have to improve all our standards of living, in order to create this kind of peaceful world there will be many difficult problems to answer, political, economic, about which I know nothing. I would only say that in order to create this safe and peaceful world, we need time, and in order to gain time we need weapons, not for aggression, not for the sake of the weapons, but for the sake of having a shield behind which we can proceed into a peaceful future.

Thank you very much, Mr. Chairman.

Senator HUMPHREY. Thank you very much, Dr. Teller.

Dr. Teller, your concluding statement, especially your emphasis upon works of peace is applauded, I am sure, by all thoughtful and sincere people. Some of us have referred to this as disarming the political atmosphere in an effort to get constructive proposals underway.

But we have questions here I am sure that we want to ask of you, and we also have with us today Dr. Jay Orear, whom we want to hear from, who is assistant professor of the department of physics at Columbia University, so I am going to move along with my questioning. We are very grateful to you for your frank and candid exposition. May I say in all candor that it is somewhat difficult to question you because some of the testimony that we get is in executive session.

LIMITATIONS WHICH SECURITY RESTRICTIONS IMPOSE UPON SCOPE OF PUBLIC INQUIRY

I have, for example, before me a transcript of testimony in executive session about which I should like to ask you questions, but I am under security restrictions and cannot because of the danger of divulging classified testimony from witnesses of the Atomic Energy Commission or the Department of Defense, or the Central Intelligence Agency.

Now this is a real problem that we have, and I don't want to violate what are accepted standards. After all, when we sit on this committee if we take something in executive session we have to respect it. You can see the problem.

Dr. TELLER. Sir, may I say that I should be delighted to appear in executive session as well.

Senator HUMPHREY. What I am trying to say is that it is a little difficult sometimes, for me at least, to phrase questions on the inspection issue because some of the material that I have had on the inspection question has been given in secret testimony which I am not per-

mitted to divulge in public discussion. Therefore, the public record cannot be as complete as it ought to be.

Dr. TELLER. Yes, sir.

GOVERNOR STASSEN'S NUCLEAR WEAPONS INSPECTION TASK FORCE

Senator HUMPHREY. Now, Doctor Teller, let me ask you this question. Were you a member of the Nuclear Weapons Inspection Task Force of Governor Stassen?

Dr. TELLER. Yes, sir.

Senator HUMPHREY. Along with Dr. Ernest Lawrence, who was the chairman, I believe, is that correct?

Dr. TELLER. Yes, that is correct.

Senator HUMPHREY. We attempted on several occasions to obtain reports for this subcommittee of the conclusions and recommendations of that task force, but to no avail.

I know that you were but a member of it, and this was apparently official policy. We have never been able to see what you recommended. But you were advising Governor Stassen, is that correct?

Dr. TELLER. Correct.

GOVERNOR STASSEN'S PROPOSAL AT LONDON CONFERENCE

Senator HUMPHREY. Governor Stassen represented our Government at the London Disarmament Conference. That is a fact, is it not?

Dr. TELLER. That is a fact.

Senator HUMPHREY. And in so doing he was represented and advocating official American policy?

Dr. TELLER. Right.

Senator HUMPHREY. Did Governor Stassen advocate a disarmament negotiation or agreement on the subject of suspension of nuclear tests along with a cutoff of production on nuclear materials for weapons purposes with international inspection?

Dr. TELLER. As far as I know, the answer is yes, and I am sure that you are better informed on the subject than I am.

Senator HUMPHREY. Well, he did. I think it is fair to say that the President of the United States has recently said that we are prepared to negotiate with the Soviet Union a cessation of nuclear bomb tests, along with a stoppage on the production of nuclear materials for weapons purposes together with international inspection.

That is the administration's position, is it not?

Dr. TELLER. As far as I know, this was the administration's position at the time which you mention.

RÉSUMÉ OF MAIN POINTS OF DR. TELLER'S TESTIMONY

Senator HUMPHREY. You are, as I have indicated, and everyone knows, one of our foremost scientists and we are deeply grateful to you. But this is what bothers me, and I say this to you in the utmost respect for your views. You have said today as I recall that it is exceedingly difficult to inspect the cutoff of nuclear materials in nuclear plants, is that correct?

Dr. TELLER. Right.

Senator HUMPHREY. You have said that it is impossible to inspect stockpiles, is that correct?

Dr. TELLER. Very close to impossible, and could be done only in an atmosphere of complete openness and even then I would have doubts about it.

Senator HUMPHREY. You have also said, as I understand it, that with the exception of the big weapons—and you did not draw the line as to what you meant by smaller weapons—that it is possible to cheat or to avoid detection?

Dr. TELLER. May I say I cannot ever be quite certain about this, but this is my guess and I should like to say that it is a guess to which I hold strongly, and which is not a guess of very recent origin.

SECRECY PLEDGE TO GOVERNOR STASSEN

Senator HUMPHREY. You have made these views known to the proper officials in our Government, have you not?

Dr. TELLER. Sir, I am sure that I try to do the proper thing.

Let me perhaps tell you under what difficulty I am suffering. Governor Stassen has enjoined us never to say anything, anything at all, that went on in our discussions. He has enjoined us to a greater secrecy than I have been forced to accept under any other circumstances.

I understand that he himself has refrained from discussing that period and has stuck to this secrecy.

Senator HUMPHREY. Correct.

Dr. TELLER. I don't like it, but I believe I have to abide by it, and therefore you will have to guess what I said or did not say to Governor Stassen. If Governor Stassen will release me from this promise, I would be delighted to tell you in executive session everything I said to him and in open session that portion that can be said openly as far as the law of the land permits.

Senator HUMPHREY. Governor Stassen is now released from any responsibilities. I cannot quite see how the contractual relationship still exists. But since he is no longer in charge of the disarmament matters, have the Secretary of State and Mr. Wadsworth placed the same inhibitions upon current discussions?

Dr. TELLER. I had no detailed discussions with either of them, and I never had the privilege of meeting Mr. Dulles.

PROBLEMS IN SECURING MEANINGFUL INSPECTION

Senator HUMPHREY. I am asking further questions only for the following reason: It has been the view of this Senator that if the policy of our Government is to negotiate with the Soviet Union a limited disarmament agreement, a beginning, whether it is on the stopping of tests alone or the cessation of tests plus the stoppage of the production of materials, with inspection, and then a very prominent scientist that works for this Government and dedicates his life to the protection of our country, comes before a committee and says that inspection is hazardous, that it is impossible on the stockpiling and that it is very difficult on the production cutoff of nuclear materials, and at best that it could lead to avoidance and cheating by the Soviet, this is cause for concern.

Dr. TELLER. Sir, I understand, and I am also concerned.

Senator HUMPHREY. You see, this is the problem that faces this committee. I must say for my own observation here that of course our President must balance off many considerations. After all, he is the President. He is not the head of the Academy of Sciences, and he must consider many factors. Today, for example, you have indicated that the development in weapons size and design makes it more difficult to inspect, is that correct?

Dr. TELLER. I'm sorry, sir, I did not clearly understand your question.

Senator HUMPHREY. I said I believe you indicated that the new developments of weapons design and size made it more difficult to have effective inspection.

EFFECT OF TIME UPON POSSIBILITY OF EFFECTIVE INSPECTION OF A WEAPONS PRODUCTION CUT-OFF

Dr. TELLER. What I meant is this: That to have an inspection about production of nuclear weapons is more difficult than to have an inspection of, let us say, machine guns or airplanes. That is what I had in mind, that inspection today is much more difficult than it would have been, let us say, in the 1930's.

Senator HUMPHREY. You would not indicate that today inspection of nuclear weapons is more difficult today than it was 2 years ago?

Dr. TELLER. That I did not have in mind in this connection.

Senator HUMPHREY. I am very glad to get that point clarified.

EFFORTS OF COMMISSIONER MURRAY TO IMPRESS UPON AEC THE IMPORTANCE OF TACTICAL MOBILE WEAPONS IN CASE OF LIMITED WAR

Now one other point. We had former Commissioner Murray before this committee about 2 years ago, and while he was here he stressed the same points, sir, that you have so ably this afternoon, the need for a variety of tactical weapons, mobile weapons in case of a limited or less than total war. I believe he emphasized pretty much the same point that you did in terms of being able to use these weapons on the mass accumulations of manpower or machinery in order to scatter them and thereby protect friendly countries. He said at the same time, sir, that this was his struggle and battle in the Atomic Energy Commisson, that he wasn't able to get this kind of consideration by the Department of Defense or by the AEC. Can you comment on that?

Dr. TELLER. Sir, I can only say this: That I believe the Atomic Energy Commission has devoted and is devoting a very, very great deal of effort toward precisely the development of the things that you are mentioning.

To my way of seeing things, the actions of the Atomic Energy Commission are completely compatible with the idea that the development of these small flexible weapons has the highest priority. What discussions have gone on I am not privy to that and I cannot comment on it.

Senator HUMPHREY. I wish the record to note that I do this by reference. The testimony of former Commissioner Murray indicated at that time, I am speaking now of the time that he was a commissioner, the difficulties that he had encountered in this particular area.

Dr. TELLER. Let me perhaps say this: That we in Livermore have looked into that direction for quite a few years, and at the very time, at the very period which you are referring to we have made big strides in this direction under full encouragement from the whole Commission.

Now I certainly feel that Commissioner Murray has pushed in that direction. I am not aware of it that anyone else has had a really different opinion, but on what shade these opinions may have differed, I cannot tell.

AVAILABILITY OF INFORMATION TO DEPARTMENT OF DEFENSE

Senator HUMPHREY. Dr. Teller, the information that you have given us here today has been made available to the Department of Defense and to the Central Intelligence Agency and the other agencies of Government, is that correct?

Dr. TELLER. I have checked my statement with several responsible individuals.

Senator HUMPHREY. Do you know Dr. English?

Dr. TELLER. I do.

Senator HUMPHREY. You do?

Dr. TELLER. Yes.

TECHNICAL FEASIBILITY OF INSPECTION AND CONTROL OF PRODUCTION OF FISSIONABLE MATERIAL

Senator HUMPHREY. Dr. English stated, and this is the testimony which we are permitted to release, and I quote:

> In summary, inspection and control of operating plants producing fissionable material is technically feasible within the limits of the assurances described, and the costs in terms of manpower and dollars are reasonable, although the difficulties in recruitment and drain on technical manpower must be recognized as a serious problem.

Dr. English testified before this Committee—this has been released, this is the galley proof which was released, I believe, yesterday. It is technically feasible and that the costs in terms of manpower and dollars are reasonable, although the difficulties of recruitment and drain on technical manpower must be recognized as a serious problem.

Now he was at this point in his testimony discussing the cutoff on the production of nuclear materials for weapons purposes. You are familiar, of course, with the French weapons expert, Jules Moch.

REPUTATION OF JULES MOCH

Dr. TELLER. I have never met him. I have heard of him.

Senator HUMPHREY. You know of his reputation?

Dr. TELLER. I know of him.

Senator HUMPHREY. Would you consider him to be a responsible official in this matter?

Dr. TELLER. I would.

Senator SYMINGTON. Would the Chair yield?

Senator HUMPHREY. Yes.

Senator SYMINGTON. If he doesn't know him, would the answer be responsive?

Senator HUMPHREY. He said he didn't know him. I ask if he knows of his reputation.

Dr. TELLER. May I please say I rather believe that he is a very responsible person, but I would say that all of us can make mistakes. I may be mistaken and any of the excellent people from whom you quote might also be mistaken, and I certainly would like to hear the question.

Senator HUMPHREY. I am not arguing with you. I am merely stating what others have said and you can make your observations on it.

Dr. TELLER. I will.

FEASIBILITY OF INSTALLING ADEQUATE INSPECTION SYSTEM

Senator HUMPHREY. After all, we are getting the testimony of many people. In the statement before this committee by Admiral Strauss, he testified as to the possibility of inspection of the cutoff of nuclear materials production. He indicated in regard to inspection for a cutoff that while an adequate system of control and inspection cannot be simple, nevertheless it should be feasible to install such a system.

The French defense expert, Jules Moch, has asserted that assuming all nuclear facilities are declared or are known—

> On the whole, less staff is required in a large country to control the cutoff of manufacture for military purposes than to verify that there are no secret explosions.

Mr. Moch further asserts that as of this time there are less than 100 nuclear facilities in the world that would need to be inspected.

I ask you for your comment on both Admiral Strauss' and Mr. Moch's comments.

Dr. TELLER. It was not quite clear to me which is which, but perhaps let me try to comment on the whole situation.

Senator HUMPHREY. I want to clear this up because this has been a point which has come up again and again.

We have had real disagreement about the possibility of suspension of tests with inspection, but there has been a statement to the effect that it was easier to establish an inspection system on the cutoff of production. I just want to get your feeling as to which of the two were more feasible.

Dr. TELLER. Let me please comment on that quite briefly. Let me start by saying that I know more about nuclear explosives than I know about the intricate mechanism and interaction of the many parts in a production facility.

I am therefore somewhat out of my field and want so to qualify my statement.

Senator HUMPHREY. But you did make some rather affirmative statements.

Dr. TELLER. I did, and I will expand on them. I don't claim that I am not competent at all. I am only claiming that I am less competent.

Senator HUMPHREY. Yes, indeed.

Dr. TELLER. I would first of all like to say that, for instance, as far as the statement of Mr. English is concerned, the public version of which I have read, I don't see there any discussion about the active measures that somebody might take to hide and divert some produc-

tion. There may be whole secret plants. There may be camouflaged secret parts to existing plants. There has been an assumption that this is difficult to do. I do not think that it is terribly difficult.

The total accountability to within 2 or 3 percent is an exceedingly difficult thing to do, and this Mr. English himself admits.

In a situation where there will be more and more nuclear powerplants, even those 2 or 3 percent diverted—or more likely 5 or 10 percent diverted—could have a very important effect. I also would like to say that we had many discussions—by "we" I mean some of my friends in Livermore and I—and among them I consider one person, Dr. Mark Mills, who has been quite recently killed in a helicopter accident in the Pacific, I considered him quite an outstanding expert, and I know that I can talk for him when I say that such inspection—he looked into it—that such inspection is exceedingly difficult to enforce, and I believe that this is indeed true.

DR. ENGLISH AND THE INSPECTION OF PRODUCTION CUTOFF OF FISSIONABLE MATERIAL

Senator HUMPHREY. Dr. Teller, may I just read this and then I shall drop the point, because you see here is where laymen like myself, and I can only speak for myself, find some difficulty in reconciling points of view.

Dr. English did give us an elaborate system of control including manpower facilities. He laid before this subcommittee the most up-to-date recent information by the Atomic Energy Commission and the others involved in the inspection and control apparatus. When asked about the inspection cutoff, I mean the production cutoff, Dr. English replies:

> What I have tried to show you here is that you, in fact, can tell that there has been a cessation of production for weapons purposes. You can control the materials within the limits I have given here, and those limits are that, with the kind of systems here described installed in every production plant, you can suspect a diversion 9 times out of 10, if that diversion is as much as 1 percent of the output. These limits are such that the amount which could be diverted unsuspected would represent a small amount compared to the now existing stockpiles of material, so that one could not argue that there was much buildup of weapons stockpiles in comparision with those which now exist.
>
> The point I am trying to make here today is that, in fact, it is possible to control, and not hold back, the peaceful uses of atomic energy. What it will cost you is money, manpower. But these, I personally think, are reasonable in terms of the money that is going into the operation now, and certainly reasonable in terms of money being spent on armaments. The risk you take is within the limits of your inability to determine small diversions.

Now we continued on this for quite a period of time, and it was the view, I think I am fair in saying this, that Dr. English felt that while there were some risks involved, that the detection and inspection system that could be devised within reasonable costs and manpower was sufficiently controlling so as to prevent diversion of any substantial amount, in fact a small portion of less than 1 percent.

Dr. TELLER. Sir, may I comment on this a little bit in detail? As far as I understand these inspection systems, they essentially assume cooperation. Let me, for instance, say this: Here is a nuclear reactor. Something goes wrong. You have to shut it off. It is a little hot. People cannot enter where they usually enter. It is very easy to manufacture, to produce such an incident, but by the time things are

cleaned up, some material has disappeared. It is easy to suspect. It is all but impossible to prove. After a shutdown, further checking becomes difficult for a few months. If then you would continue to produce without an accident, then it might again be easier to check. But then unfortunately another accident might have occurred. I don't know that this will be the subterfuge, but things of this kind could easily happen.

DANGER TO SAFETY OF EVER-INCREASING NUMBER OF EXPLOSIVES

Let me say something else. All this discussion about production shutdown, a field with which I am not so familiar, has a bearing on nuclear explosives, a field with which I am more familiar, and about that I would like to make an additional point. Usually it is assumed that more and more weapons will make the dangers greater and greater. I think that this may well be wrong. When you have few weapons the only really effective thing you seem to be able to do with them is to attack the easy targets. The easy targets are the cities or at best the airfields. The moment you have big amounts, you can spend one nuclear explosive to bring down a single plane, to bring down a single missile, to destroy a single tank.

Under those conditions you begin to use these things in a really defensive manner. More nuclear weapons may add to general safety and make the situation less dangerous, and I think that this is in fact the case.

WILLINGNESS OF U. S. TO NEGOTIATE AN AGREEMENT ON INTERNATIONAL INSPECTION OF TEST SUSPENSION AND PRODUCTION CUTOFF

Senator HUMPHREY. Doctor, I am going to permit my colleagues to question you further because many of them have questions. My point in raising the issue of the inspection matter with you, sir, was simply this: When Mr. Stassen was our negotiator and, presently, with the Secretary of State as the spokesman and Mr. Wadsworth, the President's special appointee, our position as a Government, as I understand it, is still that we are prepared any time, any place, any hour, to negotiate with the Soviet Union an agreement providing international inspection for a cutoff on production as well as the cessation of tests.

Now if that is our position, I wonder how we can justify that position in light of your testimony. You have said here today that an inspection system is rather unreliable; isn't that the body of your testimony?

Dr. TELLER. It is, sir.

RÉSUMÉ OF DR. TELLER'S TESTIMONY

Senator HUMPHREY. You have said here that it is very difficult to inspect, particularly existing stockpiles of nuclear materials; is that correct?

Dr. TELLER. That is correct.

Senator HUMPHREY. You have also said that it is possible for the Soviet to do substantial cheating on an agreement.

Dr. TELLER. This is my belief.

Senator HUMPHREY. You have further said that this is an advantage to the Soviet Union, is that correct?

Dr. TELLER. That is what I think.

DESIRABILITY OF INSPECTION TEAMS FOR CESSATION OF NUCLEAR TESTS

Senator HUMPHREY. And you have felt that an inspection system if entered into, even an international inspection system, which went deep into the Iron Curtain countries, that such an inspection system would not be of advantage to the United States, but would rather slow up our development more than theirs, is that correct?

Dr. TELLER. Not quite. I have outlined one method of combination of underground testing and clean explosions in the atmosphere combined with inspection teams which go in to check explosions. I stated about this that this particular thing could be worked out, and that it might very well turn out to be advantageous. In this way we would all cooperate in keeping the additional radioactivity in the atmosphere to a minimal level. This would include inspection teams. I do not feel competent to say that this would be a very good idea, but I think it is a hopeful one and we should look into it. I would not condemn in an unqualified fashion the idea of inspection teams.

Senator HUMPHREY. You would not condemn in an unqualified manner the idea of inspection teams, but you feel inspection teams for the cessation of nuclear tests is desirable?

Dr. TELLER. I feel that that is not desirable. If it is just cessation without further qualifications, I believe that such an arrangement would be an extremely dangerous thing.

RESEARCH FOR PEACEFUL PURPOSES UNDER SUPERVISION OF AN INTERNATIONAL AGENCY

Senator HUMPHREY. Would you approve or support a proposal for peaceful purposes and research so that we might continue the work in plants like Livermore and Los Alamos, that such work go on under the supervision of an international agency such as the United Nations.

Dr. TELLER. As I have said in my statement, I believe that such supervision would mean that we completely lay open information on nuclear explosives to the whole world. This I think is the only effective way of doing it.

I believe that this would have very serious consequences. I believe that this would enable many additional countries to produce nuclear explosives much sooner. It would tell the Russians everything we know. We would not have a real assurance that they would also tell us everything they know.

That step, therefore, is one which one should not undertake without very careful consideration.

On the other hand, it would mean close cooperation with many people in the world. It would raise positive problems. It would raise the possibility of the kind of cooperation which might have advantages great enough to compensate these enormous disadvantages which I have mentioned. I would certainly not advocate it, but I think that very carefully and slowly one might want to consider it.

Senator HUMPHREY. Thank you, Dr. Teller. I want to yield to my colleagues here.

Senator Sparkman?

Senator SPARKMAN. Let Senator Symington go ahead. I have no questions.

DIFFICULTY CREATED BY DISAGREEMENT AMONG SCIENTISTS

Senator SYMINGTON. Dr. Teller, as our very able chairman has pointed out, we are mixed up about these matters.

It is very difficult when you scientists disagree for us to know what is true and what is not true. I have read with great interest your recent book, and if in that book your statements are accurate, then other testimony that we have had before this committee, some of it largely in executive session, is inaccurate. If we are going to arrive, which God hope we do, at any form of agreement for peace through disarmament, ultimately I suppose this body that we are members of will have to make a decision, if it is in the form of a treaty, and I think it is important that we find out as much as we can about what is the truth of these subjects. I am sure you agree with that.

SECRECY IN GOVERNMENT

This whole question of secrecy, since I have been in the Senate and even before, when I was on the other side of Government, worries me. Don't you agree that we have too much secrecy in this whole field of atomic energy?

Dr. TELLER. I certainly wish we had less. I also would like to say that in the recent past a great deal has been done to diminish secrecy. The whole field of nuclear reactors has been opened up under the administration of the present chairman of the Atomic Energy Commission. I hope that this procedure will go further and much further, and it will proceed fast. That would by my hope, sir.

DR. TELLER'S BOOK AND THE DANGERS OF CONTINUED NUCLEAR TESTS

Senator SYMINGTON. Now a few questions on the specifics of the danger of the present testing. On page 124 of your book you give a list of reduced life expectancy, for example, being 10 percent overweight, one and a half years, smoking one pack of cigarettes a day, 9 years. I'm glad I don't smoke.

I am running through these. Living in the city instead of the country, 5 years; automobile accidents, 1 year. And then going to the last point, the worldwide fallout lifetime dose at present level, 1 to 2 days. That is correct, is it not, as you remember it?

Dr. TELLER. This has been quoted, all but the last entry, from a reputable statistician, Dr. Handin Jones. I mean by a biological statistician, I am sure it is correctly quoted. Such statistics are not terribly reliable. It has been quoted for general comparative purposes.

Senator SYMINGTON. And then you have a chart, how people get radiation, in which you show that worldwide fallout as of the last Russian tests was less than you would get in the way of radiation if you lived in a wooden house instead of a brick house or less than the gamma rays from the ground or less than the luminous dial wrist

watch, less than radium in water for the average citizen, less than cosmic rays at sea level, and a great deal less than, say, a chest X-ray. Your coauthor is Dr. Latter, is that right?

Dr. TELLER. Correct.

EXTENT IN ROENTGENS TO WHICH FALLOUT HAS INCREASED IN PAST FEW MONTHS

Senator SYMINGTON. It disturbs us because obviously you can make a better product for peace if you go into that in detail if you test than if you don't. However, have you any information as to—you say the worldwide fallout up until the time this book was written which came out in March, say in the last few months—and there has been a great deal of talk about the Russians having contaminated the air since then with a series of tests that they made prior to their decision to stop testing.

Have you any information as to how much further the danger has extended in roentgens, I am talking about worldwide fallout now, not about local fallout, how much the danger has extended as a result of the latest tests of the Russians.

Dr. TELLER. I would not be able to tell you accurately. Let me perhaps put it this way: The book, the manuscript of the book, has been of course put in quite sometime ago.

Senator SYMINGTON. Right.

Dr. TELLER. Quite a few months ago, and let's take it as of that date rather than the date of publication which is quite recent.

Senator SYMINGTON. Will you tell us what that date was roughly, then?

Dr. TELLER. Oh, last summer or early fall. Books take a little time to get out. And if you take it as of that date, then the Russians will have added since then I would say less than a day, probably quite a bit less than a day. We know, of course, more about our own tests than we know about the Russian tests, and therefore I cannot be so terribly accurate about it. But if we said there in the book 1 or 2 days, then I would now instead say 2 days.

Senator SYMINGTON. Now let's talk specifics.

You say based on your chart the way you have it, you have considerably less than one roentgen of radiation, is that correct?

Dr. TELLER. The lifetime dose is quite a bit less, is less than one roentgen, due to fallout.

Senator SYMINGTON. Five to ten as against one to two, so it must be less.

Dr. TELLER. Excuse me?

Senator SYMINGTON. It is five to ten as against one to two. In other words, you say one roentgen of radiation is equivalent to 5 to 10 days reduced life expectancy.

Dr. TELLER. That is right.

ROENTGENS OF RADIATION RECEIVED BY PEOPLE OF RONGELAP

Senator SYMINGTON. And the worldwide fallout as of the book last fall or summer was 1 to 2 days. Now how much radiation did the people on that island, Rongelap? How many roentgens did they get?

Dr. TELLER. The people in Rongelap got, as far as we know, 175 roentgens. This is not an exact figure but a pretty good one, I think, the estimate is 175 roentgens.

Senator SYMINGTON. 175?

Dr. TELLER. Right, and they got it all at once, you see, which is much more dangerous than to get the same amount spread out in time.

ROENTGENS OF RADIATION RECEIVED ON JAPANESE SHIP, "FUKI MARU"

Senator SYMINGTON. And what was it on the *Fuki Maru*, that Japanese ship?

Dr. TELLER. As far as I recall it is 200, but that is even less certain because we did not make measurements on the ship.

Senator SYMINGTON. As I remember your book, only one man died on the ship and they think he might have died of hepatitis or something, is that correct?

Dr. TELLER. That is correct.

Senator SYMINGTON. And the rest got well and all the natives got well.

Dr. TELLER. That is correct.

Senator SYMINGTON. So far as is known, although they are still being watched.

Dr. TELLER. They are still being watched and some of the effects of radiation show up years later. Some of them might still be affected.

ADVERTISEMENT ON DESTRUCTIVENESS OF NUCLEAR BOMBS AND THE DANGERS TO HEALTH OF CONTINUED TESTS

Senator SYMINGTON. Now, Dr. Teller, in the New York Times on Friday, April 11, 1958, is a full page advertisement.

It says:

Nuclear bombs can destroy all life in war. Nuclear tests are endangering our health right now.

Then it is signed by a good many different people, and I would like to read a little bit of that to you and have you comment on it, if you will.

The first point they make is:

The Soviet Union states it is calling off further nuclear tests. The easiest way for us to convert this announcement into a moral disaster for the United States is to stand pat on this issue. The least we can do today if we hope to restore American moral standing in the world is to postpone our tests. President Eisenhower's able seventh letter to Khrushchev regained some of the ground lost by our first response to the Soviet announcement. The President's recommendations for technical studies preliminary to a broad disarmament agreement deserve the widest possible support, but much more has to be done.

It is true that the Soviet Union waited until it completed its spring tests which sharply increased poisonous radioactive strontium in the atmosphere, but it makes no sense for the United States to complain about radioactivity from the Russian tests and then plan to add to it with our own tests. Estimated nuclear box score to date, United States 100 odd tests, Soviet Union, 50 odd tests.

Would you comment on that up to that point?

Dr. TELLER. Quite a few statements there.

Senator SYMINGTON. Yes. The one that interests me the most, and perhaps does you, is the question of sharply increased poisonous radioactive strontium in the atmosphere—the fact that they have done it,

and the fact that we have done it. I am trying to get the significance of the advertisement as a layman, which I am.

The fact they have done it means that if we do it we will do the same, and therefore, we should not do it.

Dr. TELLER. The word "poisonous" seems to me perhaps not quite rightly used. I would say that the effect on the individual is not proven. We do not know whether these exceedingly small amounts of radioactivity are harmful at all. It has been often claimed in the past, for decades in fact, that some radiation in the water is useful, a completely unjustified and unscientific statement.

The signers of this kind of a statement have never protested against that. They have never protested against anything else of this kind. I have seen that advertisement myself. I notice the absence of one very respected name there, Professor Mueller, a geneticist, who did protest against excessive use of X-ray machines for chest X-rays and for excessive use of X-rays in fitting shoes.

Now I would like to add that if there is a way of countering Soviet propaganda, it would be for some of our people to use more self-restraint in putting out ill-considered advertisements.

Senator SYMINGTON. Now, Doctor, this advertisement goes on and says:

> The United States Atomic Energy Commission now admits that radioactive fallout is a matter for genuine concern, and that the United States is the hottest radioactive place in the world. Scientists warn that thousands of babies will be born malformed because of tests to date. Many thousands more people will prematurely die of diseases of blood and bone.

Many millions of Americans are going to read this advertisement. Apparently it is going to be distributed and all we want to know is the truth. What are your comments on that?

Dr. TELLER. We do not know that a single person will die prematurely from diseases of blood and bone. As far as I could find out by very careful study and questioning, this is an assumption. It is not a known fact.

As far as genetic influences are concerned, there is a very high probability, that there will be some mutations. If you multiply the probability with the number of people on the earth, nearly three billion, the number of mutations will come into the many thousands. That is correct. But not all mutations are harmful.

If we would condemn all mutations, we would condemn all biological progress as well. It is very hard to even recognize something that is progress when it first comes out. What is different, when it first appears, looks wrong. I think that statements that "all mutations are harmful" or "there are practically no useful mutations," are ill-considered statements. I think that the whole advertisement has the kind of a bias which will criticize fallout, but gives no thought to the question that mutations can be caused by the X-rays, or by many other ways in which we change our lives and which through chemical actions, through temperature action, through radiation, we can get many, many more mutations than by anything we have done by nuclear tests.

Senator SYMINGTON. This advertisement uses your name. As long as I am reading parts of it, there are a couple more excerpts I would like to read. I might add it says:

> Write President Eisenhower, write your Senators and Representatives—

and so forth. We don't see you very often, and I would like to get your ideas on this subject.

It says:

Dr. Libby of the Atomic Energy Commission concedes the detection of nuclear explosions is feasible, contrary to the much-publicized doubts of Dr. Teller.

As I understand it, you have said today, your testimony today does not quite bear out that statement, isn't that correct? You say that you can detect some explosions, the larger ones, and you cannot detect the smaller ones.

Dr. TELLER. I think that is the correct situation, the correct description of the situation as of today. However, I have also said that future research is likely to push up the limit in the sense that more and more explosions can be hidden as we find out more and more about this matter.

Senator SYMINGTON. Do you know of any disagreement between you and Dr. Libby of the Atomic Energy Commission on this matter?

Dr. TELLER. I believe that Dr. Libby has expressed himself much more cautiously than I did. He said maybe one can detect, maybe one cannot detect. That is essentially as I understand him. I believe that there is no substantial disagreement between us.

Senator SYMINGTON. My impression of your opinion of his thinking, based on his testimony before the Committee, I believe that you are correct in your estimate of what his testimony was, maybe yes, maybe no.

Now finally, on this advertisement—there are several other points here. It says:

Bills now before Congress would authorize transfer of bomb materials, parts and weapons design blueprints to other countries. This would mean more nuclear powers and so extend the suicide club. Korea is pressing for nuclear arms. NATO is seeking them. Turkey will certainly want them, then Pakistan. Moscow will make Communist China a nuclear power. Fuses could be set all over the world. We would increase the chance of accidental atomic war.

And so forth. Now the Senate has before it consideration of giving out further atomic information. If there is going to be any peaceful cooperation in the atomic field, there has to be some dissemination of information on our part as well as that of other people who know about this, like the British, the French, and the Russians, isn't that correct?

Dr. TELLER. Most certainly.

PEACEFUL USES OF NUCLEAR ENERGY AND SHARING INFORMATION WITH OUR ALLIES

Senator SYMINGTON. I remember in the patent pool problem when I was in private business you used to be approached to go into a pool on the basis of do you think your laboratories know more than all the other laboratories combined on particular subjects.

So if we are going into the question of peacetime reactors and so forth, and try to use nuclear energy as a way to improve the standards of living of the human race, then we have to also give information with respect to those problems or characteristics incident to weapons, do we not?

Dr. TELLER. Absolutely, and I believe that we ought fully to cooperate with our allies to build up our collective defenses, and such collective defense will make the world safer than more unsafe.

Senator HUMPHREY. Will the Senator yield?

Senator SYMINGTON. I will be glad to.

Senator HUMPHREY. The reason I asked the Senator to yield at this point, I earlier understood you to say that you had some concern about the development of peaceful uses of explosions because under an international agreement the knowledge of nuclear explosives would spread and might lead to more countries coming into the weapons field, is that correct?

Dr. TELLER. It is correct. What I meant to say, however, was that it would at once spread it all over the world, and we would lose control completely.

If instead we cooperate with our allies under clearly understood and controlled conditions for the purpose of our mutual defense and for the exploitation for peaceful purposes, this I think if rightly formulated would be a positive advantage which I should like to advocate.

Senator HUMPHREY. And you would expect the Soviet Union not to stand still under these circumstances?

Dr. TELLER. Certainly not.

Senator HUMPHREY. They undoubtedly would want to become a little friendly and fraternize a bit with their satellites on the possibility of this spread of the weaponry, is that not true?

Dr. TELLER. It is hard for me sometimes to understand what people will do and why they will do it even when I know them.

Whether under those conditions the people in the Kremlin will try to get their satellites in closer, to what extent they can trust their slave people, to what extent they are afraid of Communist China, sir, your guess will be much better than mine.

Senator HUMPHREY. I can appreciate that.

ADVERTISEMENT ON DESTRUCTIVENESS OF NUCLEAR BOMBS AND THE DANGERS TO HEALTH OF CONTINUED TESTS

Senator SYMINGTON. Now finally on this advertisement, Dr. Teller, it says:

> America must give leadership for world disarmament and conditions that make for a just and workable peace. We must stop the contamination of the air, the milk children drink, and the food we eat. While there is yet time, let us come to life on this issue and take the moral initiative.

This is a persuasive advertisement, especially to people who have not studied the subject perhaps. What would be your comment on this statement:

> We should come to life on this issue, take the moral issue, stop contaminating the air, the milk children drink, the food we eat.

Dr. TELLER. Misleading, exaggerated; nevertheless I am in complete agreement with the statement that we must take the moral leadership, only these people do not know what moral leadership is. Certainly it is not to distort facts and to exaggerate them and frighten people as they do.

DR. TELLER'S BOOK ON USE OF THE WORD "RIVALS"

Senator SYMINGTON. You say at the end of your book:

Rivals are men who fight over the control of a river. When the same word "rivals" comes to mean cooperation for the best common use of a river or any other resource, that will be the time of law and of peace.

Dr. TELLER. And I think that time will come.

Senator SYMINGTON. I remember that sentence. That is the way you feel about it, is that correct?

Dr. TELLER. That is how I hope and how I feel; yes, sir.

POSSIBILITY OF MAKING DETECTABLE TESTS ILLEGAL AND UNDETECTABLE TESTS LEGAL

Senator SYMINGTON. I have several more questions here. This committee heard testimony that perhaps it would be all right when you get down to the technical details of working this situation out with the Communists to consider all tests large enough to be detected illegal, but the ones which cannot be detected could be considered legal. That was what one of the witnesses presented as an idea. What do you think of that?

Dr. TELLER. I don't think it can be done, for this reason. Let us take just an example of underground shots. The question is not whether an underground shot can be noticed. The question is whether it can be distinguished from an earthquake.

Now if it would be legal to make those shots where the discrimination is hard or impossible, then we could bootleg indeed by lying. If I want to implement that, I would have to say: you see this disturbance on a seismograph but that is an earthquake. In reality it was a shot.

I could get away only by lying and by organized lying. Hiding tests means organized lying, and organized lying is something that cannot be exercised in this country, but which can be safely practiced in Russia.

Senator SYMINGTON. In other words, with the premise that the test that is detected is illegal, but the test that isn't is legal, if we wanted to work on that, we would have to ask the people in charge of the operations not to tell the truth.

Dr. TELLER. And under those conditions, sir, I would have nothing to do with such an operation.

DUTIES OF AN INSPECTION TEAM

Senator SYMINGTON. I imagine there would be others that would feel the same way about it. I understand that when the seismograph indicates a suspicious earthquake, an inspection team would go out and verify whether it was an earthquake or a nuclear explosion. Can you tell us what this inspection team would actually have to do in order to verify that?

Dr. TELLER. It would have to go on the spot, look around, find where the hole had been dug originally. Other surface effects would practically not exist. These holes could be camouflaged very easily.

I think that inspection team would have an extremely difficult job. The only real way to check would be to bore in and find the radio-

activity. In our own shot where we knew precisely where we had set if off, it took us a long time to find it. The seismographic determination of the position is not very accurate.

To try and bore and find the radioactivity would be a practically hopeless procedure. I think that it is only the very big shots where you could spend a whole lot of time and research and exploration. If you would have to do that let's say once a year, it might be possible to resolve any doubts. But it seems to me that these inspection teams would have an exceedingly difficult time.

DIFFICULTY OF LOCATING RAINIER EXPLOSION

Senator SYMINGTON. The fact is that we had quite a lot of trouble in our underground explosion in finding it.

Dr. TELLER. That's right.

Senator SYMINGTON. It happened for some time, didn't it?

Dr. TELLER. I tried to say it took us quite a long time to get in there. Actually we proceeded quite cautiously, and we might have done it in a little shorter time, but I think we took about 4 months and we knew where it was.

Now I don't want to mislead you. Our main aim was not to hurry, and if we had hurried, we could have done it faster, but we also knew where it was.

DESCRIPTION OF THE REACTOR SAFEGUARD COMMITTEE AND ITS FUNCTION

Senator SYMINGTON. Doctor, as I say we want to get all sides of this situation. You at least think you know enough about the fallout of nuclear weapons to write a book about it, and as I understand it, you were Chairman of the Reactor Safeguard Committee of the Atomic Energy Commission, is that correct?

Dr. TELLER. That is correct, sir, yes.

Senator SYMINGTON. What is that Reactor Safeguard Committee? I never heard of it until very recently. What does that do in the Atomic Energy Commission?

Dr. TELLER. It was organized in 1947, if I remember correctly. I was its first chairman. I stayed chairman for several years. Then another person stepped in, a very good friend of mine, and I continued to serve for a few years, and a few more years. Then I left it all together because I had too many other things to do.

What we did and what they are still doing is to look into each reactor very carefully to see that it is humanly certain that it will not mulfunction and release its radioactive poisonous products. These products in a reactor are present in sufficiently great concentration that in this case they are poisonous.

When they are in the negligible concentration in which we are getting them from the tests, then it is quite misleading to call them poisonous. We don't even surely know that they are harmful.

COMPARISON OF FALLOUT FROM WEAPONS WITH THAT FROM NUCLEAR REACTOR ACCIDENTS

Senator SYMINGTON. With that background would you give us a comparison in your opinion of fallout from weapons as against fallout from nuclear reactor accidents?

I might say the first person who acquainted me with the latter danger was the distinguished Chairman of the Joint Atomic Energy Committee, the senior Senator from New Mexico, who is gracing our hearing today. I didn't know anything about that aspect of it at all until he told me about it one day.

Dr. TELLER. Well, I would consider reactors more dangerous for a number of reasons. One is that when a reactor functions for a long time, the short-lived activities continue to decay, but the long-lived activities, those which live for a month, for a year, accumulate.

These long-lived ones are the most dangerous ones because they have time to get into the human system, and in terms of these, one of the presently planned reactors is as radioactive as a megaton bomb.

Now of course such a reactor if it malfunctions won't explode. It just lets its radiation seep out or it may burn or there may be an explosion which might kill people in the immediate neighborhood but an explosion which as an explosion is not terribly dangerous. At any rate, there won't be an enormous amount of heat released in this accident.

The result is that since there is not much heat, the dangerous reactor products stay down and can be carried in the downwind direction to a mile, to 10 miles, to 50 miles. In the downwind direction there will be acute danger and a much greater danger than there would be in a megaton explosion where most of the radioactive products are carried up to a high altitude and would therefore not act in a concentrated fashion in which we know they are dangerous.

Extreme precautions have to be taken and have been taken and so far we have been both cautious and lucky. As usual the Atomic Energy Commission has a very high safety record.

RESTRICTION OF INFORMATION REGARDING SIZE OF BOMBS

Senator SYMINGTON. Doctor, you said small bombs can be hidden and big bombs can be detected. The people like to know these things. They will make the final decisions. They are the people whose future is at stake.

Why do we have to be so secret about some of these problems? Can't you tell us how big you think a bomb can be before it can be detected?

Dr. TELLER. Sir, I wish I could. As far as I know, and maybe I am overcautious, but as far as I know the regulations are that at this point I must not answer in open session.

I would be happy to mention it, but at present I could give you these figures unfortunately only in executive session.

RESPONSIBILITY FOR REGULATIONS GOVERNING CLASSIFIED INFORMATION

Senator SYMINGTON. Who makes the regulations?

Dr. TELLER. I think you, sir.

Senator ANDERSON. What is the answer, Doctor?

Dr. TELLER. I think the Congress of the United States makes these regulations.

Senator ANDERSON. You had better look into that a little bit.

Dr. TELLER. I may be mistaken. I believe that the Atomic Energy Commission merely interprets them. I might be completely wrong, sir.

Senator ANDERSON. I can just assure you you are 100 percent wrong.

Dr. TELLER. Thank you, sir.

Senator SYMINGTON. We will have Admiral Strauss tomorrow and see whether you are 150 percent wrong.

OTHER METHODS OF HIDING NUCLEAR EXPLOSIONS

Now you said there are other methods of hiding nuclear explosions than the method of detonating the bomb underground. Would you elaborate on that a bit?

Dr. TELLER. I think I can. I think that it would be reasonably safe for me to say that there are methods which are not so much in the technical field but which are certainly in the psychological field. The Russians might take one of these objects, put it on a submarine and then take appropriate measures, get their explosion off and then blame it on us. The Russians who succeeded in convincing many people that we used germ warfare might get away with a stunt like this.

There are still other methods. I feel sure that I could give you a more complete answer in executive session.

In this instance incidentally I almost think that there is a point in not talking about it too much because I don't quite feel like saying openly how one can cheat before sitting down to a poker game.

Senator HUMPHREY. We don't want you to give anybody any ideas about that.

Dr. TELLER. That is what I more or less have in mind, not that my ideas need be so very good, but they might be by chance.

POSSIBILITY OF REACHING SOME POLITICAL AND COOPERATIVE AGREEMENT WITH RUSSIANS

Senator SYMINGTON. My next to the last question is that: You said that we should remove the causes of war. How would you go about that? Do you think we can reach an agreement with the Russians?

Dr. TELLER. I think we could reach an agreement with the Russians about many positive things, and I suppose many of these may lie in the field of politics. These do not lie in my field, but some are in my field.

Senator SYMINGTON. For example, exchange students?

Dr. TELLER. Well, that is more in my field. I think it would be wonderful if they exchange students, and the more the better. I think the cooperation which we now have in the Geophysical Year is an excellent idea. The only thing that I don't like about it is the year. Why not the Geophysical Age?

Why not continue with it? I think of the possibility in meteorology of better prediction and better control of the weather. It would be just wonderful.

Actually the Russians, and even the Chinese do give us data on their weather conditions which are helpful for the forecasting of the weather all over the globe. I think this is a beginning which should be worked on.

I think that the use of science is something on which the future of mankind depends, and positive cooperation on these topics is something that I would advocate as far as is reasonable and possible.

POSSIBLE EFFECT OF EXTENSIVE WORK ON WEAPONS UPON IDEAS IN FAVOR OF CONTINUED NUCLEAR TESTS

Senator SYMINGTON. Doctor, my final question: It is a little personal. If you don't care to answer it, why that is all right with me.

But you worked on weapons for the United States, and although I am sure you don't like the appellation, you have been called the father of the hydrogen bomb. You worked on implements of war.

Is it possible that your eagerness to produce the right weapons has distorted your ideas about what could be done in the way of disarmament?

Dr. TELLER. Sir, I don't want to decline to answer the question. Let me say this:

To know one's self, to know one's own motives is a very difficult thing, and I don't claim to know myself. But I answer your question to the best of my knowledge, and I shall say this:

I chose the profession of a scientist, and I am in love with science and I would not do willingly or eagerly anything else but pure science because it is beautiful and my interest is there.

During the war I had to work on weapons because I knew the reason and I wanted to. After the war in a dangerous period when, as you all know, the hydrogen bomb was at stake, I worked again, and I felt I had to because it was a task which had to be undertaken, if we were not to fall behind the Russians in a very important field.

And because I knew that very many of my friends were unwilling to work on it, I felt that those few of us who were willing to do so should do all the more.

Now as we see in Sputnik and further developments, there are very clear indications that we are losing the arms race, and therefore not because I like to do it but because it is a necessity I am again devoting my full attention to weapons.

I don't like weapons. I would like to have peace. But for peace we need weapons, and I do not think that my views are distorted. I would like to stop this if we could have a peaceful world, and I just hope I can contribute, and I believe I am contributing, to a peaceful world.

Senator SYMINGTON. Thank you, Mr. Chairman.

Senator HUMPHREY. Thank you, Senator Symington. Before I turn the questioning over to Senator Sparkman, I would just like to make this one observation. Possibly the Doctor could make a suggestion or an observation on it from his own point of view.

REFERENCE BY SECRETARY DULLES TO THE KILLIAN COMMITTEE CONCLUSION ON POSSIBILITY OF RELIABLE INSPECTION SYSTEM

Secretary Dulles in a press conference last week, following some comment relating to the work of the Killian Committee upon which Dr. Bethe, who is going to testify before us, serves, and others, had this to say:

Very definitely they—

meaning the Killian Committee—

come to the conclusion that a fairly complex system is required to eliminate totally the risk. I don't think they believe that any system of supervision would be proof against all possible evasions. But I think there is one factor that we can probably take into account, namely, that if there is an agreement to suspend, an international agreement coupled with sufficient supervision so that there would be a high degree of probability that evasion would be detected, then that of itself creates a considerable likelihood that evasion will not be attempted. That is because the consequences of an evasion that gets caught might be so serious as to more than balance out the advantages of the surreptitious testing.

I have read the transcript of Secretary Dulles' conference of last week. This obviously implies that an effective system to inspect is possible, at least according to Mr. Dulles' interpretation. This has been stated by others at the policy level.

AVAILABILITY OF KILLIAN COMMITTEE REPORT TO THE SUBCOMMITTEE AND THE PUBLIC

In view of the conflict between yourself, Doctor, and others—you are not alone, may I say, and I want the record quite clear on this—and between you and what seems to be the interpretation of the Killian Committee as expressed by the Secretary of State, it seems that we would be properly advised if we requested that the Killian Committee report be made public, or at least be made available to this subcommittee. I go right back to what Senator Symington said before. We are not trying to choose up sides in this at all. What we are seeking is information, and that is why we asked you to come.

PROBLEM OF HEARING SOME WITNESSES IN EXECUTIVE SESSION AND OTHERS IN PUBLIC SESSION

As I said to you earlier, it is so difficult to get a public evaluation of this. We hear in public the positive affirmative statements which you make relating to the unreliability of testing and to the dangers implicit therein because of the possibilities of evasion. But what Mr. Scoville says is in executive session, what Dr. Starbird says in part is in executive session—we released as much as we could—and what certain others have said is in executive session.

So you see on the one hand you get this very effective presentation, and I surely commend you. You make your point well and we respect what you say.

But, on the other hand, we have capable witnesses coming in here who disagree. But we are not at liberty to say how much they disagree, do you see?

Dr. TELLER. Senator, it is perfectly clear from what I have said, that I advocate and I hope you will agree, I practice the maximum possible

openness. If needed I will be glad to comment in executive session on further points for your information.

I furthermore would like to say that I am not the appropriate person to have a definite opinion on it, but I hope that substantial parts of the Killian report will be made public, and I certainly would hope that your subcommittee would see all of it.

I don't know whether I should go into reiteration of some of my points of view, because where there appears to be a difference between what you have quoted and what I have said, I will simply have to stick to what I have said.

Senator HUMPHREY. Indeed, sir, and we surely respect your right to say it, and obviously this subcommittee will take it very seriously, because you are a highly respected man.

I only add that just as you pointed out the possibility of cheating because of new methods and new trickery in which the Soviets might engage, so we have had testimony here before this subcommittee as to the great advances that have been made in detection since even last year.

Dr. TELLER. Well, sir, 'et me perhaps tell you that detection is a field on which we have worked and worked and worked, and there was something on which to try it out. On hiding, we worked very little indeed. And I would like to hear somebody challenge that.

Senator HUMPHREY. I have been of the opinion, Doctor, that anybody that worked on a detection system would at the same time be trying to think about every possible scheme that somebody might do to avoid it.

Dr. TELLER. No, sir, because so far our detection systems were primarily directed against that kind of testing where there is no attempt at hiding, where the very fact of radioactivity broadcasts the event.

NUMBER OF INSPECTION STATIONS IN SOVIET UNION UNDER GOVERNOR STASSEN'S PROPOSAL

Senator HUMPHREY. In executive session I am going to ask you to comment about Mr. Stassen's proposal in which he said that 12 stations in the Soviet Union would do the job, provided that you had equipped seismic, acoustic, electromagnetic, and radiation measuring equipment—or you might want to comment on it now.

Dr. TELLER. Since you mention numbers, I think that a meaningful answer of the kind of which I can be sure that I am not violating any regulation should best wait for the executive session. I may be too cautious, but I feel that I must to the fullest possible extent honor existing rules.

Senator HUMPHREY. We surely want you to, sir. Senator Sparkman?

Senator SPARKMAN. Mr. Chairman, I am glad to know that Dr. Teller is to appear before us in executive session, because I can only repeat what you and Senator Symington have said: That having listened to these different witnesses, we hardly know just what to believe.

I am glad that Dr. Teller is coming into executive session, because I hardly see how, but there might be some possibility of reconciling some of these differences that we know to exist among the witnesses.

SUMMARY OF DR. TELLER'S TESTIMONY

I shall be very brief. Let me ask you some very simple questions more or less summarizing this. I take it from your testimony that you believe that it is imperative that we continue testing, is that right?

Dr. TELLER. Precisely.

Senator SPARKMAN. And also that you believe that inspection cannot be made foolproof or completely effective?

Dr. TELLER. It may be, I am not sure of this, but it may be foolproof as far as certain big explosions are concerned.

I feel that the overwhelming weight of probability is that evasion is possible in the field of small nuclear explosions, and I have tried to point out the importance of these small explosions.

Senator SPARKMAN. I believe you said a while ago, in answer to a question of Senator Symington, that you did not feel that it was proper for you to differentiate as between big and small. Will you be able to do that in executive session?

Dr. TELLER. What I said was that I cannot draw the line as to what is big and what is small. In executive session I certainly will do so.

I have made a statement, Senator Sparkman, before you came in about this. There exists a difference of opinion where the line has to be drawn.

Senator SPARKMAN. Now I was interested in one thing you said. You thought we might be able to make some progress toward disarmament or toward working out some kind of agreement, I believe you said, with Russia through cooperation in programs of different kinds.

Dr. TELLER. Indeed.

Senator SPARKMAN. You mentioned weather reports, meteorology, the International Geophysical Year operations.

Dr. TELLER. Many other things.

Senator SPARKMAN. And you can think of many others?

Dr. TELLER. One occurs to me right away, oceanography.

Senator SPARKMAN. What?

Dr. TELLER. Oceanography, the study of the oceans, just the shape of the ocean, the currents in the ocean, life in the ocean, the possibility of farming the oceans, things of that kind.

Senator SPARKMAN. And exchange of persons, ideas, information?

Dr. TELLER. All of these, yes, sir.

Senator SPARKMAN. Do you believe that all of these things such as that, that we engage in, help to move us toward a better understanding that might culminate in our working out something?

Dr. TELLER. Perhaps I am foolishly hopeful, but this is my hope, and I think that direct contact between people, progress toward a common goal, is a wonderful unifying principle.

I think that one of the worst things that the Russians have done is to erect the Iron Curtain, and we should take every opportunity we possibly have to tear it down.

Senator SPARKMAN. I certainly agree with you. Mr. Chairman, that is all, thank you.

ADVANTAGE OF DEBATING POSSIBILITY OF INTERNATIONAL INSPECTION SYSTEM

Senator HUMPHREY. On that last point, Dr. Teller, some people have felt that just to obtain some form of international inspection

apparatus or personnel behind the Iron Curtain might be a very significant breakthrough into this monolithic, tightly knit society.

Dr. TELLER. Sir, I believe that a concrete proposal which has been discussed here, inspection of earthquakes, is to obtain a minimum penetration for maximum loss in our military security.

INTRODUCTION OF SENATOR ANDERSON

Senator HUMPHREY. Senator Anderson is with us today, and we are very, very pleased, because of his prominent role in the whole field of atomic energy. I have asked Senator Anderson, with the concurrence of my colleagues, to take some time here to ask you a few questions, since he knows more about the technical aspects of this subject than the chairman of this subcommittee does.

I won't speak for my colleagues, but I have a feeling that they would concur. That goes for all of us.

Senator ANDERSON. I understand, Mr. Chairman, I came here as a guest and I appreciate the opportunity of coming here. I am very much interested in the work that you are doing, and I applaud you for that.

RULES PROHIBITING DISCUSSION OF SIZE OF NUCLEAR WEAPONS

Dr. Teller, you know that my activity on the Joint Committee has given me an opportunity to become well acquainted with the many fine contributions that you have made, and I have appreciated those and have many times expressed my appreciation of them, so that if today I ask you questions that may look as if I am in contradiction to you, I hope they will be taken in the same recognition of my long-time respect for you and my great admiration for your work.

Doctor, this question of detection is a puzzling one. When I said we don't make the rules on it, the Congress has said to the Atomic Energy Commission, "Be careful," but it hasn't said that you can talk about a certain sized explosion and not talk about another sized explosion.

Dr. TELLER. I recognize that, sir.

Senator ANDERSON. The regulation has to be made by them, as it should be.

Dr. TELLER. Yes.

Senator ANDERSON. You said that you believed small tests could be hidden. Can you give us any idea how small is small?

Dr. TELLER. My understanding of the rules is that this is precisely the point at which I have to stop talking in an open meeting.

May I please say that I did not seek explicit advice on this particular point, and if I am wrong, the blame is on me, and I will have been just simply cautious. I can assure you that I would like to say it publicly. If I say it later in executive session, and if a ruling would be obtained where this part of my testimony can be published, I should be happy.

Senator ANDERSON. Doctor, I want you to be cautious. One of the things that we pride ourselves on is the caution with which many people have handled these subjects.

SIZE OF DETECTED RUSSIAN TESTS

But now you know as a matter of fact that long before Russia announced what its tests had been, that this country knew those tests had taken place. Were not some of those tests small?

Dr. TELLER. I have discussed the hiding of small and big weapons from the point of view of underground testing, and about those we have exceedingly little experience.

RAINIER TEST AND PROBLEM OF DISTINGUISHING EXPLOSION OF THIS SIZE FROM EARTHQUAKE

Senator ANDERSON. The one we had out in Nevada, that was certainly small.

Dr. TELLER. One point seven kilotons. That was published.

Senator ANDERSON. I was just looking for myself to see that I wasn't giving away classified information.

Dr. TELLER. No. I checked up on that. All of that is unclassified.

Senator ANDERSON. One point seven kilotons. That is about 12 percent of the Hiroshima blast, and the Hiroshima blast is about one one-thousandth of what we are capable of, so certainly this one in Nevada is a small test by any yardstick. Now that was detected 2,300 miles away?

Dr. TELLER. Yes, sir, but I have tried to say, and if I may ask your indulgence I will say it again, the question is not to detect. The question is to discriminate this particular thing from earthquakes.

Now of this size there are very, very many earthquakes, and to go in and check on them, namely, on those of the earthquakes which look like a nuclear test, would be such an enormous effort that I would like to say that it is not practical.

However, let me say this. I am not saying that it would not be practical for the 1.7 kilotons. I am saying that the fact that it has been detected does not say anything yet. You see, I am not saying that the line will lie below 1.7 kilotons or above 1.7 kilotons.

I am merely saying that the statement that this thing has been discovered 2,300 miles away is not the relevant statement. The relevant statement which any seismologist can tell you, is that the detection at 2,300 miles did not tell you whether it was an earthquake or whether it was a nuclear explosion.

Senator ANDERSON. You also know, do you not, that there were many people who looked at the design and thought it did show a nuclear test because the lines were not comparable to the lines of an earthquake.

Dr. TELLER. I am sorry, I don't understand.

Senator ANDERSON. Did not people who examined the pattern of the record made in Alaska feel that those lines that were drawn on the chart were not the lines of an earthquake?

Dr. TELLER. As far as I understand the situation, I have to disagree with that, sir.

Senator SYMINGTON. Will the Senator yield for just one point?

Dr. TELLER. May I please say I can explain that in executive session easily.

Here I have simply to say that this is a difficult question, and that there exists a definite possibility of confusion between earthquakes and nuclear explosions. Whether this comes at 1.7 kilotons, whether it

comes at a distance of 2,300 miles or at what distance, this begins to get into the classified area, and you are pushing me on that, sir, and so I am nervous.

The only point about it that I would like to say is that this discrimination is very difficult. The very fact of detection is unquestioned, but that is not the relevant fact. The discrimination is the relevant fact, and that is not unquestioned and has to be discussed later, and carefully.

AEC STATEMENT ON THE MAXIMUM DISTANCE AT WHICH RAINIER SHOT WAS DETECTED

Senator SYMINGTON. Dr. Teller, this advertisement that I brought up with you mentioned the fact that the AEC has said that last year's underground test in Nevada was detected only 250 miles away. Now it is revealed that the test was detected in Alaska 2,300 miles away.

A hydrogen bomb is many thousands of times more powerful than the "tiny" bomb used in the underground tests. I would have read that to you, but Admiral Strauss is coming before the committee tomorrow, and it seemed to me that that was a matter of administration, a problem of administration and not a problem of technology.

I thank the Senator from New Mexico for yielding to me at that point. I did not want anyone to think that I was avoiding bringing that matter up. Admiral Strauss is coming up tomorrow.

Senator ANDERSON. May I say when the Livermore Laboratory got the preliminary report of the press release that was to be handed out, the Livermore Laboratory phoned to the Albuquerque office and said the 250-mile figure is ridiculous. They got it in Denver, which is 600 miles away, they got it in Alaska, which is 2,300 miles away, and days later the report was still put out 250 miles.

He can explain that as he will when he comes here. I am a little sorry that it came up, but I did not like the fact that it was not corrected, because the man in the very laboratory in which you work was energetic and vigorous, as you are, to try to make it read correctly, instead of in a misleading fashion.

Dr. TELLER. May I please volunteer one opinion of which I am strongly convinced, although it is clearly the kind of opinion which is very difficult to prove.

I am convinced that wherever there has been a slipup, it was a slipup and it was not an act of trying to mislead anybody in an intentional fashion. This is my conviction, sir.

Senator ANDERSON. I am real sure of that, but the man who had charge of releasing the press release with the incorrect figures in it came back here and was not put on the stand to testify. I am sure that was in the interest of exposing the complete truth.

IMPROVEMENT IN DETECTION DEVICES AND DISCLOSURE OF INFORMATION

Now the March 25th test of the Russian Government was not too many times larger than the explosion at Nevada of 1.7 kilotons. That was detected a long distance away.

Would it not be a fair statement, Dr. Teller, to say that the devices with which we detected the first explosions within the Soviet empire

were primitive compared to the abilities of the present detection machinery?

Dr. TELLER. May I please say as far as the present detection machinery is concerned, with which we detect these explosions, I simply do not know how much of that is classified.

I shall be exceedingly happy to tell you as much as I know, and I do not know everything about these things, far from it, but as much as I know about this I shall be happy to explain to you in executive session.

Senator HUMPHREY. Would the Senator yield?

Senator ANDERSON. I only want to say to Dr. Teller you will never get me to urge you to talk about classified material if you think it is classified.

Dr. TELLER. I don't know.

Senator ANDERSON. But we can release a statement on the Russian bomb explosion and tell its size, and I don't believe we are concealing anything from the Russians by saying we can do it. They know it too. They can read our newspapers.

Let me give you one example. When we had a little incident in South Carolina, we announced there had been a certain number of incidents. The Russians announced that we had nine.

The figure nine is closer to the truth than that released in this country, so I don't think we have gained anything by keeping that information from the Russians.

Dr. TELLER. Sir, may I simply give a statement as to the argument given on the other side, and I just simply want to quote it as best I can.

We do not want to disclose our methods of detection. Now whether this is the right thing or not I do not know. I generally don't like to urge secrecy, but I would like to say that this much of a counter argument might conceivably be made.

SOURCE OF INFORMATION

Senator HUMPHREY. Will the Senator yield at this point, since I was involved somewhat in this business with the AEC.

It is not necessary to disclose sources and means of detection in order to disclose size, design, yield, et cetera, and the qualities of nuclear explosions in the Soviet Union, is it?

Dr. TELLER. What we know we know exclusively from our detection equipment.

Senator HUMPHREY. Of course.

Dr. TELLER. All the rest is inference. Therefore what we disclose is either uncertain, because it is at the end of a long chain of an argument, or else it is a more or less direct disclosure of what we have seen. Insofar as it is a disclosure of our actual observations, it does give away something about the observing equipment.

Now I would like to say this: That whether or not it is worthwhile to keep secrets of that kind I do not know, and as I say, my general feeling is that it would be better to be more open. In any particular case, I know it is a lengthy and difficult argument, and I am not the proper person to comment on it.

DISTANCE AT WHICH TEST COULD BE DETECTED AMONG OBJECTIVES OF RAINIER TEST

Senator HUMPHREY. Since Senator Anderson brought up the Rainier underground test, which, by the way, as everyone knows, was public knowledge because the AEC told everybody we were going to do it, I want to call to his attention that one of the purposes of that test was to measure and evaluate seismic signals and fission at distances extending from the point of detonation out to all distances where the signals could be detected. That was point 6 as released in the study under contract No. W7405 Engineer 48 U. S. Atomic Energy Commission.

Now in the evaluation of that detonation, this same study says:

Records were available from 7 of these stations located 110 to 350 miles from the test detonation.

My only point is that with that point 6 being one of the reasons for the test, the evaluation of the test which was published as an official Government document does not tell all which the Government knew unqualifiedly, unmistakably, and that was our only argument with it.

PUBLICATION OF DISTANCE AT WHICH RAINER EXPLOSION WAS DETECTED

If they didn't want to put it in that it was 110 to 350 miles, that is O. K. by me, but if they are going to put in the distance they ought to put in the correct distances. That is all.

Senator ANDERSON. Of course publication of distances would have destroyed all this argument about detection. It was detected in Denver 600 miles away. Don't put it in this report. Say 350. It was detected in Alaska. Put only 350 in the report.

I say to you, Dr. Teller, the shocking thing to people is that the Livermore Laboratory, and I can give you the name of the man who did the phone calling, because I have it in my office, the Livermore Laboratory took a precaution to phone and say this press release should not go out. It contains bad information in view of this point. You must correct it to show what the exact distances were.

And days later the report was turned out with the incorrect information, making some people wonder if it wasn't turned out that way to prove a point. I know all the stories about how a series of unusual and unbelievable things happened, none of which ever happened before in the history of the office.

I do not blame, as you well know, the Livermore Laboratory, because your man who did the phoning in was trying to make sure that it did not hurt to let the people know the truth.

CONTROL OF RADIOACTIVE FALLOUT FROM NUCLEAR TESTS

I am a little worried about the question of conducting the tests so that a very negligible amount of radiation particles will be produced in comparison with all former blasts. I think what you have said is absolutely true as far as this country is concerned but, Doctor, we would not have any control over other countries who conduct tests, would we?

Dr. TELLER. Sir, what I would like to suggest for discussion is an agreement of this general kind. We might agree that there might be a certain size, for instance 5 kilotons, for instance 10 kilotons. Don't take the numbers too seriously. Let us agree that all above-ground explosions or all atmospheric explosions of that size or greater, must be registered with the United Nations. These explosions will be permitted provided observation teams go out to the explosion, and provided that these observation teams are shown by appropriate methods how much radioactivity there has been put into the air by this one rather big explosion.

Then one should also agree what the total share of each country in additional radioactivity should be per year, and one should convince in that fashion the whole world that one is essentially keeping this kind of an agreement. We have announced our intention to make a step in this direction by setting up a demonstration test for next summer. And indeed I am happy to say that we have taken this essential step in a peaceful direction before the Russians came out with their meaningless blast of temporarily stopping their explosions after the completion of a series.

Senator ANDERSON. Doctor, I want to just say to you that after thinking about this subject and studying it a great deal, that I have to express my agreement with what you have said, and say to you that I am glad somebody is willing to stand up and say it.

In the first place, it was proposed some years ago that other nations be invited to watch testing. It was not regarded proper at that time, now it is, and I think it is a fine thing, and I am glad that you recognize it.

A long time ago I suggested, as the Los Alamos scientists suggested in hearings here, that we have some limitation on the amount of fissionable products that go into the atmosphere, and make sure that we don't put more into the atmosphere than decays out each year.

I would put a whole lot less than decays out each year, but I do want to say that what you have just said is something which I will examine more carefully as I read it, but I think I find myself in full agreement, and I am happy you have said it.

Furthermore, I want to say to you that what you have said about stockpiles and the impossibility of checking stockpiles I agree with very completely, and I am glad that you have helped to clear the atmosphere on that.

INSPECTION OF LIMITATION OF PRODUCTION OF FISSIONABLE MATERIAL

As to the limiting of production, I am not so sure. Don't you suppose that if Oak Ridge or Savannah River or the Washington Plant closed down, that other countries would know it pretty quickly?

Dr. TELLER. Certainly, if it would close down they would know it.

Senator ANDERSON. It is the small parts of it that you worry about, is it?

Dr. TELLER. What I am worried about is this: You can fake an accident, which is not very bad, but which results in safety zones so that not everybody can go everywhere, and that just creates the kind of confusion where cheating and organized lying can flourish.

Senator ANDERSON. I am told they are getting ready to vote, and I want to get on to other witnesses. I will suspend my other questions. I have many others.

I again say I appreciate the opportunity of listening to you and hearing you express your opinions, some of which I thoroughly disagree with, but you state them frankly and fully, and I admire you for that, and I am happy about it.

Senator HUMPHREY. We are going to move along here as much as we would like to continue our interrogation and this very valuable testimony by Dr. Teller.

Doctor, I know that you will be willing to come back to us in executive session as you have indicated today. Your willingness is very much appreciated. I want now to ask our second witness, who is here with us, to testify, and may I say before anyone leaves the room that the next withness is Dr. Jay Orear, a very noted physicist. He will give us the benefit of his observations.

INTRODUCTION OF DR. JAY OREAR

Dr. Orear is the Assistant Professor in the Department of Physics at Columbia University. Between July of last year and February of this year he participated in the Columbia Inspection project sponsored by Columbia University Institute for the study of war and peace. This project is a private, unclassified study of the technical problems involved in detecting possible violations of a disarmament agreement.

Doctor Orear's specific area of study is the detection of nuclear weapons tests, including the possibility of devising a minimal inspection scheme which could detect violations of a test ban agreement.

Doctor Orear's study is very thought-provoking and has evoked some very laudatory comments. I believe the benefit of his views as a result of this study will prove helpful to the subcommittee in its search for answers to the vexing problems which plague us. I am glad that he could be with us this afternoon. I am sorry that many of the press are leaving, Doctor, because for the American people to get full information, they should listen to all of the participants. It is the responsibility of modern American journalism. Go ahead, Doctor.

STATEMENT OF DR. JAY OREAR, ASSISTANT PROFESSOR OF PHYSICS, COLUMBIA UNIVERSITY, AND MEMBER OF THE COLUMBIA UNIVERSITY INSPECTION PROJECT

Dr. OREAR. I would like to thank the Senate Disarmament Subcommittee for the opportunity to present some thoughts and ideas on disarmament which are an outgrowth of the Columbia University technical study entitled "Inspection for Disarmament." The final draft of this report is close to completion and is not yet available. However, I have just submitted copies of the final draft of my paper on nuclear weapons testing to this committee.

Senator HUMPHREY. That will be received for the record.

(The matter referred to is as follows:)

THE DETECTION OF NUCLEAR WEAPONS TESTING

(By Prof. Jay Orear,[1] department of physics, Columbia University)

I. INTRODUCTION

This paper will discuss the problem of detecting possible violations of an agreement banning nuclear weapons testing. Such an agreement could either be a part of a general disarmament agreement, or it could be a separate "first stage" agreement.

It is well known that many unannounced nuclear weapons tests have been detected at large distances by various monitoring techniques. This paper is mainly devoted to the technical question: Under what conditions are these techniques sufficient to detect violations of a test-ban agreement? In particular it is of importance to know whether such a monitoring system is so simple and foolproof that it would not encroach upon a nation's internal security. Because monitoring stations present almost no interference with internal security, a test ban has often been proposed as a possible "first step" to disarmament. It would not in itself be disarmament, but it could be a test of good faith which could lead to further agreements. In fact the establishment of monitoring stations by an international inspectorate throughout the entire Soviet Union and United States would in itself be more progress toward disarmament than has been made in the last 12 years. Most other types of disarmament agreements would require a degree of inspection and free access which a limited access nation like Russia would be reluctant to accept.

It will be shown in this paper that an adequate inspection system for a test ban would require the establishment of monitoring stations at various locations deep inside large geographical testing areas. About 25 such stations uniformly distributed throughout the Soviet Union and 7 such stations within the United States should be sufficient for these 2 testing areas. If the presently existing seismic stations were required to mail copies of their records to the international inspectorate, this number of stations could be vastly reduced. For example, the existence of 4 or 5 international seismic stations in the Soviet Union make alteration of the records of the other 75 existing stations an impossibility. There is hope that such an inspection system would be acceptable to Russia, since it was Soviet Delegate Valerian Zorin who proposed in the June 14, 1957, meeting of the UN Disarmament Subcommittee that the test-ban agreement "be implemented by scientific control posts to be set up in the United States, Union of Soviet Socalist Republics, United Kingdom, and Pacific Ocean areas."

The main techniques for detection of nuclear weapons testing are: (a) Detection of acoustic waves, (b) detection of seismic waves, (c) detection of electromagnetic radiation, (d) detection of radioactivity. These techniques will now be discussed in more detail.

II. METHODS OF DETECTION

Detection of acoustic waves

Much of the radiation released in a nuclear explosion gets degraded by atomic processes to kinetic energy of the air molecules. Except in the immediate region of blast effects, this disturbance travels with the speed of sound and can be detected by sensitive microbarometers.[2-6] This technique accurately gives the location and time of the test, and also gives a measure of the size of the explosion (yield in kilotons of TNT). The general feeling is that except for deep underground explosions, and except for those of subnominal yield,[7] nuclear tests can be detected at very large distances by this technique. Thus

[1] Jay Orear is Assistant Professor of Physics at Columbia University. His major research field is high energy physics.

[2] R. Yamamoto, Bulletin of the Institute for Chemical Research, Kyoto University, Supplementary Issue November 1954, pp. 120–133.

[3] R. Yamamoto, Bull. Amer. Meteorological Soc. 37, 406 (1956).

[4] "Preliminary Report on the Atmospheric Pressure Oscillation Due to the H-bomb Explosion" by the Observation Division of the Central Meteorological Observatory of Japan, pp. 105–113 of "Research in the Effects and Influences of the Nuclear Bomb Test Explosions."

[5] "The Preliminary Report of the Investigations of Atmospheric Pressure Caused by Nuclear Test Explosions" by the Observation Division, Japan Meteorological Agency, March 10, 1957, unpublished.

[6] Private communications from Drs. M. Taketani and S. Kawabata.

[7] Nominal yield is defined as that of a Hiroshima-type bomb.

low yield tests of just a few kilotons TNT equivalent would probably require monitoring stations within large testing areas. Low yield tests could probably be detected at distances up to a few hundred miles.[8] If we require that every point be within 300 miles of a monitoring station, about 25 stations would be needed within the borders of the Soviet Union and 7 inside the United States. See figures 1 and 2. A similar density of stations would be needed in other possible testing areas. In general, the microbarographic technique of detection is the most sensitive and would usually be the most relied upon. The special problem of very low yield tests is discussed in section III. The problem of deep underground tests is treated in the following discussion on seismic waves. The problem of very high altitude tests is discussed in the section on electromagnetic radiation. In this case there will still be an acoustic wave, but its magnitude may be reduced.

Detection of Seismic Waves

In air, underwater, and surface explosions, a significant fraction of the energy is transferred to the ground as seismic waves. Thus, all tests whether underground or not, give rise to seismic waves which can be detected within certain distances. Air bursts in the megaton range have been detected all over the earth.[9] The 1946 Bikini Baker test was detected by seismograph in the United States.[10] This was a shallow, underwater test of nominal yield. Recent Nevada low yield air bursts have been detected by seismological stations hundreds of miles away.[11] The September 19, 1957 deep underground test (Rainier) of 1.7 kiloton yield was detected as far as College, Alaska.[12] Seismic records can tell the location and time of the explosion with great precision. The monitor network proposed in this paper using recent unpublished information on travel times of bomb tests can probably locate a test site within one mile (assuming local "calibration" explosions are made). Seismic techniques can give some measure of the size of an explosion for deep underground tests.

As with the acoustic wave, the seismic wave cannot be detected at very large distances for subnominal tests. For example, the Japanese have not detected our Nevada tests by seismograph. However, small explosions can be detected by stations within several hundred miles. An extreme example of detection sensitivity is a recent experiment in the Soviet Union where chemical bombs of 0.0001 kilotons (100 kg of TNT) were detected beyond 200 miles by special techniques. One would expect that low yield underground tests down to 0.1 kilotron should give good seismic signals up to 300 miles.

However, several dozen natural earthquakes of comparable magnitude can occur per year in the Soviet Union or United States. For detection of deep underground tests to be practical, one needs a technique of analysis which can distinguish most of the earthquakes from manmade explosions. One would expect that such a technique is possible because of the striking differences between the mechanism which produces earthquakes and an explosion. An earthquake is produced by slipping of ground along a fault plane. It is usually a broader and deeper source of longer time duration than an explosion. This large difference in the initial earth motion excites different kinds of waves which are different in polarization, rise time, radiation pattern, frequency, duration, relative amplitudes, etc. The initial longitudinal wave pattern from an earthquake tends to be a cloverleaf, with the leaves alternating in polarity (direction of first motion). For an explosion the initial longitudinal wave pattern tends to be uniform and is always a compression rather than a rarefaction. Transverse waves can be generated by reflection and refraction of the longitudinal wave. But this mechanism initially produces transverse waves of vertical polarization, while the initial transverse earthquake waves can have large horizontal polarization.

In the proposed network of 300-mile monitoring stations, the worst possible case would be a test which is at the maximum distance of 300 miles. But in this case there would also be about 3 other stations in the other 3 directions at

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[8] Private communication from Dr. S. Kawabata, chief of Observation Division, Japan Meteorological Agency. Dr. Kawabata says: "Assume an observatory every 300 miles is placed in Soviet territory and these observatories are equipped with very sensitive seismographs, microbarographs, and instruments to detect radioactivity. In this case, we think we can detect all of the explosions." See also reference 18.

[9] T. N. Burke-Gaffney and K. E. Bullen, Australian Journal of Physics *10*, 130 (1957).

[10] K. E. Bullen, Nature *161*, 62 (1948).

[11] "Seismic Wave Travel Times From Nuclear Explosions," D. S. Carder and L. F. Bailey, unpublished.

[12] The New York Times, March 12, 1958.

FIGURE 1.—MINIMUM NUMBER OF STATIONS TO MEET 300-MILE REQUIREMENT

FIGURE 2.—MINIMUM NUMBER OF UNITED STATES STATIONS TO MEET 300-MILE REQUIREMENT

300 miles. The test would be ringed by about 12 stations within 600 miles. Suppose an earthquake occurred at such a location. Then, about half the station would be located where the longitudinal initial polarity is R-type. The existence of just one such record would definitely establish the disturbance as an earthquake and not a bomb. By this technique alone, probably the vast majority of earthquakes in the magnitude range $M>4.5$ can be eliminated assuming the 300-mile stations. For example, the initial polarity of the Rainier test ($M=4.6$) was definitely established as far as Pinedale, Wyo., 520 miles away. Now that more is being learned about the seismic records of large combs, new techniques and methods of analysis should improve the situation.

The feasibility of monitoring deep underground tests also depends upon the abundance of natural earthquakes. In this discussion we will use the land area within the borders of the Soviet Union as an example. In the U. S. S. R. the average rate of earthquakes greater than magnitude 6 ($M>6$) in the period 1920 to 1942 was about 3 per year.[13] The world totals are estimated to be 124 per year for $M>6$, 920 per year for $M>5$, and 7,100 per year for $M>4$.[13] According to this there should be about 24 Soviet earthquakes per year with $M>5$ and about 60 per year with $M>4.5$. This may be an underestimate because after 1952 the earthquake rate in the Kamchatka peninsula has increased.

We will now show that deep underground tests of bombs of several kilotons should be in the region of $M>5$ and that very low yield tests of about one kiloton should be in the region $M>4.5$. The most recent relation between energy release (E in ergs) and magnitude is[14]

$$\text{Log } E=9.4+2.14M-0.054M^2$$

According to this relation the most catastrophic natural earthquake ever recorded ($M=8.6$) has the same energy release as a 15 Megaton bomb. Thus man has exceeded the "forces of nature." This is contrary to the impression given by the United States Atomic Energy Commission. The energy release of 1 kiloton of TNT would be $M=5.5$. However, a nuclear bomb air burst has only 50 percent of its energy as blast energy. The rest is electromagnetic radiation and radioactivity. Also underground blast energy can be used in rock deformation in addition to seismic wave energy. According to the information available to this author prior to March 1958, a safe assumption was that at least 10 percent of the energy of a deep underground nuclear bomb would go into seismic waves. The recent estimate of K. E. Bullen[15] was consistent with this. Bullen estimated that an explosion of 30 kilotons of TNT would give $M=6$. The seismic energy in $M=6$ is 4.8 kilotons, so Bullen was using a loss factor of 6. Bullen reported the 20 kiloton Bikini Baker test as $M=5.5$.[15] This would be a loss factor of 20 or a 5 percent energy transfer. However, this was a shallow underwater test where a large amount of energy was used in shooting up a large column of water and steam. So according to the Baker test, 5 percent would be a lower limit on the amount of energy which would go into seismic waves in a deep underwater test. Using the 5 percent figure, a 1 kiloton bomb would be $M=4.7$. However, according to an AEC report released in March, 1958, the Rainier test was $M=4.6$ and 1.7 kiloton yield.[16] Assuming the AEC yield figure is correct, this is a loss factor of 50 rather than 10 and a 1 kiloton nuclear explosion could be as low as $M=4.5$. The only apparent explanation for this extra factor of 5 in the loss factor is that the Rainier test was conducted in a volcanic tuff which is easy to shatter and that an abnormal amount of energy was absorbed in shattering and deformation. Rainier was preceded by test explosions in the same rock, so the answers to these questions are known to the AEC.

Using present techniques it may occasionally be difficult to positively identify a shock of M less than 4.5 as an earthquake by stations at 300 miles. This difficulty can be largely overcome by installing a higher density of seismic stations in the seismic belts. In the case of the Soviet Union about 6 additional stations in the Kuril Islands and the Kamchatka peninsula would give 100 mile coverage.

A problem which should be considered here is the possibility of rigging up a bomb to go off "simultaneously" with an earthquake of larger magnitude. Be-

FIGURE 2.—MINIMUM NUMBER OF UNITED STATES STATIONS TO MEET 300-MILE REQUIREMENT

[13] Gutenberg and Richter, "Seismicity of the Earth," Princeton University Press, 1954.
[14] Gutenberg and Richter, Bull. of Seis. Soc. of Amer. *46*, 105 (1956).
[15] K. E. Bullen, "Seismology in Our Atomic Age," presidential address to the International Association of Seismology and the Physics of the Interior of the Earth, Toronto, Canada, Sept. 4, 1957.
[16] Johnson, Pelsor, Preston, and Violet, UCRL–5124, Office of Technical Services, Department of Commerce, Washington 25, D. C.

cause of the scarcity of earthquakes greater than magnitude 6 (about 3 per year in the U. S. S. R.), this method of deception would not be very practical for bombs giving M>6. It may be difficult to separate signals of tests giving M=5 from nearby earthquakes giving M>5.5 (about 9 per year in the U. S. S. R.). If the bomb signal is triggered by a distant earthquake, the bomb signal will arrive several minutes behind the initial earthquake signal at some stations.

In conclusion, the practical lower limit of detection and identification of deep underground tests is probably about 1 kiloton with the 300-mile network. The 100-mile network in the seismic belt should push this limit down to less than 1 kiloton. Tests somewhat above these limits might go undetected if conducted within a few seconds and within a few miles of a major earthquake (M>6). A provision which would push these limits down further and would make seismic detection more certain would be the right for an inspection team to investigate the origin of a suspicious disturbance. Such a provision would be a great deterrent to clandestine underground testing. Serious risk of possible detection would always accompany any attempt to evade.

If the parties to the test-ban agreement have reservations about the uncertainties involved in underground detection and the possibility that a very low yield test (less than I kiloton) may escape positive identification, the first stage agreement could ban only those tests which are detectable. Another possibility would be to ban all but the deep underground tests. In either case, the progress made toward improving East-West relations and the establishment of a working international inspectorate would be almost as great as that made by an agreement which included all tests. There is no reason why the test agreement should ban peaceful uses of nuclear explosions. However, such peaceful experiments should be under international supervision and be open to the inspectorate.

Complete seismological instrumentation of a monitoring station would cost 3 to 5 thousand dollars using commercially available items. If necessary, it should be possible to obtain seismological instruments for a few dozen stations within 6 months. Special equipment designed to distinguish earthquakes from explosions would be more expensive. A quicker and simpler solution to seismological monitoring would be to make use of existing research stations. For example, the Soviet Union has a network of about 75 high quality stations. As a part of the agreement these stations could send copies of all their seismograms to the international inspectorate. At present Soviet and United States seismologists freely exchange records upon request. There would be no risk of falsification as long as the inspectorate has a few stations of its own.

Underwater test can be detected both by the seismic waves in the earth (Bikini test Baker was M=5.5) and by the seismic waves in the water using hydrophone detectors. This latter method is very senitive because the underwater waves concentrate in the sofar layer. Thus the intensity only drops off as 1/R rather than as $1/R^2$. Underwater explosions can also be detected by the radioactivity contained in the water which rises to the surface and by the tidal waves.

Detection of electromagnetic radiation

The high frequency end of the electromagnetic spectrum (X-rays, ultraviolent) is quickly absorbed in the atmosphere and converted to lower frequency electromagnetic energy and molecular energy. Thus an appreciable part of the bomb energy travels in the regions of the electromagnetic spectrum where there is little atmospheric absorption; namely, as visible light and radio noise.

Detection of the visible light at distances up to about 300 miles is quite simple. One merely points a photocell at the sky. It doesn't matter whether it is day, night, clear, or cloudy. As long as the test is not deep underground, a very distinctively shaped light pulse will be observed.[17] The same mechanism which gives twilight after the sun has set will give a glow in the sky due to the nuclear explosion. The twilight of the sun is observable until the sun reaches 18° below the horizon. This is a distance of 1,200 miles beyond the horizon and represents an upper limit on the range. Because of the large number of photons involved, the intensity of sky glow from the bomb could be a million times smaller than the brightness of the daytime sky and still be detected. Spurious signals such as lightning would have the wrong pulse shape and also would not appear at the other stations. Directional information could be obtained by using several photocells at each station. If the stations were fed common

[17] "The Effects of Nuclear Weapons," published by the U. S. Atomic Energy Commission, June 1957.

timing signals, the bomb site could be located very accurately using the photocell signals.

In the case of a nuclear explosion well above the atmosphere, the shape of the pulse will be different, but there will still be plenty of visible light generated when the X-rays (thermal radiation corresponding to millions of degrees) emitted from the high temperature explosion hit the upper atmosphere. This same mechanism will also produce an acoustic wave. One should be able to calculate the magnitude of such an acoustic wave as compared to that of a low altitude test. If the loss in magnitude is too great, the very high altitude tests can still easily be detected at 300 miles by light and radio noise.

Detection of radioactivity

According to estimates of United States officials, one should expect that some of the future tests will have no fission content and that some current tests have had the fission content down to about 4 percent. One should keep in mind that a "a 100 percent clean bomb" is a practical impossibility due to neutron-induced activity in the bomb components and atmosphere. This is contrary to the impression given by the U. S. Atomic Energy Commission. This activity should be equivalent to about 1 percent fission content, so that if we already have bombs with only about 4 percent fission content, there is not much room for improvement.

Because of the neutron-induced activity, all except the deep underground tests will produce radioactivity which may be detected. For example, the Japanese have detected low yield Nevada tests by collecting dust from air at sea level.[18]

Because of the rapid decay, one would expect to obtain maximum sensitivity by collecting dust downstream from the test at high altitudes. The closer to the test, the greater the sensitivity. Collection at high altitudes and within about 1,000 miles of the test area would require monitor aircraft flying within foreign territory. To agree to this form of monitoring requires more of a sacrifice of internal security than the establishment of fixed ground monitoring stations. Since the fixed monitoring stations at distances of about 300 miles give adequate detection using acoustic, seismic and electromagnetic instruments, one need not rely on detection of radioactivity. On the other hand, in the absence of the internal monitoring stations, an adequate job of detection of conventional tests can be done by aircraft outside the territorial limits.

III. VERY LOW YIELD TESTS

The AEC has announced that the Nevada test of September 19, 1958, was 1.7 kilotons of yield. Such a yield is smaller than the largest chemical explosion of 4 kilotons of real TNT at Heligoland on April 18, 1947. Because of the fact that many of the Nevada tests are such a low yield, one concluded that low-yield tests are useful to modern weapons development. Since one of the purposes of a test-ban agreement is to impede weapons development, it would be desirous that such an agreement also cover low-yield tests. If the agreement covers very low-yield tests, the detection of violations becomes more difficult. A major detection problem would be how to distinguish the monitor signals of a 3 kiloton nuclear bomb from those of a 3 kiloton chemical bomb. The easiest solution to this problem is to write into the test-ban agreement a provision that whenever a nation intends a large chemical explosion, UN observers must be present. Very low-yield tests can be detected at distances of about 300 miles. Also whenever the stations have the indication of a test, the inspectors should have access to the indicated test site. Of course, ultra low-yield "tests" of yields comparable to World War II blockbusters could escape detection by the monitoring stations proposed here.

IV. UNCONVENTIONAL TESTS

We will now discuss the possibilities of evasion by using unconventional testing techniques. Two such possibilities have already been covered. These are the ultra low-yield explosion and low-yield deep underground tests which are simultaneous with earthquakes. There are two more possibilities of evasion worthy of discussion. These are testing in a giant box, and testing in foamy water.

[18] M. Taketani, "A- and H-Bomb Tests," Chapter V, published in Japanese, August 1957.

It should be possible to construct a giant box resting on pillars so that essentially no shock wave is transmitted to the ground or air. The simplest form of such a box would be a steel sphere strong enough to hold all the energy released by the bomb. Essentially all the energy of the bomb will be quickly converted to molecular kinetic energy and the gas inside the sphere will reach an equilibrium pressure P. Then $PV=0.4E$ where V is the volume of the sphere and E is the yield of the bomb. For example, if E is 1 kiloton and the sphere is 500 feet in diameter, then P=8 atmospheres. This is very close to the measured peak overpressure as given in reference 16. However, the peak overpressure on reflection would be more than twice as great. In order not to burst, such a sphere would require walls over 8 inches thick and would weigh over 100,000 tons. The weight would be almost independent of the diameter and it would be proportional to the bomb yield. Such a method of deception is not practical except for low-yield tests, and even then the construction time would probably exceed the duration of the first stage agreement.

It is well known that foamy water absorbs underwater shocks. Thus if a bomb is exploded in the center of a large volume of foamy water, the seismic energy can be absorbed. In the case of a 1 kiloton bomb the volume of gas contained in the bubbles should be about 10^{13} cm^3 when at one atmosphere pressure. The cheapest way to get such a large quantity of gas into a large volume of water is by the release of an equivalent amount of liquid nitrogen. In the case of a 1 kiloton bomb, about 10 kilotons of liquid nitrogen would be needed. The volume of water needed would be about 1,000-foot diameter sphere. This would require a disk-shaped vessel of about 1,000-foot diameter which is submerged to about 1,000 feet for the liquid nitrogen. Such a technique is expensive and is limited to low-yield tests. Furthermore, there are very few lakes with depths up to 1,000 feet. Water from such lakes could be periodically monitored for radioactivity by the inspectorate. A variation on this technique would be to build a new artificial lake of 1,000-foot depth by damming up a deep canyon. All this would be a major engineering project which would be expensive, take several years, and be limited to low-yield tests.

V. SUMMARY

We see that it is possible to detect nominal yield tests outside the boundaries of the nation conducting the test. However, subnominal tests of low fission yield could possibly escape detection from outside monitoring. Such clean small bombs have not yet been developed. Actually a test-ban agreement which could be checked only by outside monitoring still would fulfill many of the reasons for obtaining such an agreement. To restrict tests to the point where they must be undetectable by outside observers certainly does impede weapons development. The view of M. Taketani, professor of physics in Tokyo and a leader in the Japanese test-ban movement, on this is: "Underground explosions are morally preferable to explosions in the atmosphere, because the former has no fallout. In the present situation, I would like to propose, pragmatically, the cessation of all of the tests of A- and H-bombs whose explosions are detectable."

The main conclusion of this paper is that even these tests which could escape outside detection could be effectively detected if about 25 ground monitoring stations could be uniformly distributed over the Soviet Union and about 5 in the United States.[19] Several stations might also be required for Pacific Ocean areas, Australia, China, and for the nations bordering the Union of Soviet Socialist Republics and the United States of America. Then any test would be within 300 miles of at least 1 station and usually be within 600 miles of 12 stations. The 300-mile requirement proposed here may be too conservative. If so, perhaps only a few stations would be needed. For example, a 500-mile requirement on the Soviet Union can be met with 8 stations. On the other hand, it might be desirable to have a few additional seismic stations in the seismic belts. Confusion with large chemical explosions could be eliminated by a simple provision to the test-ban agreement that members of the international inspectorate must be invited to all large chemical explosions. Also, it is clear that if

[19] This conclusion is strengthened by the testimony of Dr. W. F. Libby, Acting Chairman of the U. S. Atomic Energy Commission. In testimony before a congressional commitee on March 6, 1958, Dr. Libby said, "On the technical matter of whether you could develop a system to enforce a test ban, I think you can do this. It is a much more difficult job than some people have indicated, but you can do it to the point where it will be good enough so that the chances of being caught are big enough so that it probably would be adequate."

the monitoring stations had evidence of a bomb test, the inspectorate must have access to the location in question. The number of stations could be vastly reduced by the simple requirement that existing seismic stations send copies of their records to the international inspectorate.

In the case of a general disarmament agreement, the type of large-scale inspection system necessary to prevent secret military buildup would certainly be adequate to prevent nuclear weapons testing. Such a large-scale inspection would involve inspection of areas which are now highly classified. The monitoring stations proposed here need not be set up in classified areas.

In the absence of a large-scale general inspection system or unlimited access, it would still be impossible to carry on an effective nuclear weapons testing program provided the minimum monitoring conditions proposed here were established. The objection that these minimum conditions would interfere with a nation's internal security is not valid provided the inspection personnel are confined to the monitoring station and that the monitoring station is located in normal civilian territory. Thus, the beauty of a test-ban agreement as a "first step" trial agreement is that adequate inspection can be provided without running into the usual objections that the inspection system would interfere with a nation's internal security. Apparently Russia recognizes this feature of a test-ban agreement, since it was Soviet delegate Valerian Zorin who proposed in the June 14, 1957, meeting of the U. N. Disarmament Subcommittee that the test-ban agreement "be implemented by scientific control posts to be set up in the United States, Union of Soviet Socialist Republics, United Kingdom and Pacific Ocean areas." Whether this means 22 stations in the Union of Soviet Socialist Republics would be acceptable is unknown.

FUNDAMENTAL POLICY OF THE UNITED STATES

Dr. OREAR. Let me start by assuming that it is the fundamental policy of the United States to achieve world disarmament with adequate safeguards. Then what should be the first-step agreement along these lines? By definition the first-step agreement should be one which is easiest for both sides to accept. The best possibility right now is an agreement to stop nuclear weapon tests. Russia has expressed strong willingness for such an agreement—even with inspection. It would be very difficult for Russia to back down at this stage. According to our Columbia studies, a nuclear weapons test-ban is one of the easiest to inspect. On the other hand, the inspection system our group envisages for controlling nuclear production is one of the most difficult. It requires many inspectors with free access to virtually all restricted areas. It is a widespread opinion that our Government's refusal to break up the package proposal is a gimmick to prevent agreement. Why else should it tack on the "last step" as a requirement for the "first step"?

UNITED NATIONS TEST INSPECTION AGENCY

Just how easy it is to detect secret nuclear weapons tests? Suppose tomorrow the United States and Union of Soviet Socialist Republics signed an agreement to stop all tests. I claim that by tomorrow we could also have an adequate inspection system by the simple requirement that all seismographic observatories send copies of their records to a U. N. inspection agency. The Soviet Union has about 75 high-quality seismic stations and would probably be willing to send copies of these records. At present Soviet seismologists mail out copies of their records upon request. It would be a great risk to attempt any alteration of these records because they must be self-consistent and also check with the records of the neighboring free countries such as Japan and India. The establishment of several

U. N. monitoring stations inside the Soviet Union would make it impossible to alter these records and get away with it.

The above-ground tests could adequately be monitored by these internal stations in combination with our existing external monitoring system.

DETECTION OF TESTS

Now let us consider the problem whether Russia could effectively hide tests. Actually this apparent scientific controversy which has confused the public is not a controversy. We scientists all agree about the scientific facts of detection. But we start to disagree when it comes to unscientific words such as "small bomb," "big bomb," "effective" and "adequate." We all agree that nuclear explosions can be made so small as to be undetectable. But such devices would not make practical weapons.

I believe the small bombs referred to by the previous witness are so small that they would be smaller—they are certainly smaller than anything anybody has ever used as a nuclear bomb so far. To me it is questionable whether you are going to use nuclear explosions for a hand grenade. It is cheaper and easier to use conventional weapons.

There is a fuzzy dividing line on the size of explosion which is detectable. This dividing line is at a safe, low level. In the case of a deep underground test which occurs "simultaneously" with a large earthquake, this fuzzy dividing line is somewhat higher, but still at the safe, low level on the order of a kiloton.

DISTINGUISHING BETWEEN NUCLEAR EXPLOSION AND EARTHQUAKE SEISMOGRAPH RECORDINGS

Senator HUMPHREY. Are you saying there, Dr. Orear, that even where the seismograph may have at the same time recordings of an earthquake and a nuclear explosion, that if the explosion is larger than a kiloton, that it is possible to ascertain the fact of a nuclear explosion?

Dr. OREAR. By kiloton, I mean kiloton region, and this is where I put this fuzzy dividing line. What I mean by fuzzy dividing line is that sometimes you can get away with it and sometimes you couldn't.

Actually if you took the risk of waiting for an earthquake to come along, you would not know what the final seismic signals are going to look like until after it was all over, and you always have risk of getting caught.

Senator HUMPHREY. And being caught means the deal is off, doesn't it?

Dr. OREAR. Yes.

Senator HUMPHREY. The verification of the cheating is the enforcement device in the agreement. When the agreement has been violated, the agreement is no longer binding.

Dr. OREAR. Right. Just a little later I would like to discuss the question, suppose we do have such a suspicious signal from all these monitoring stations.

Don't forget now I am talking about hundreds of monitoring stations, because we are making use of all of the existing stations that are all over the world, these existing seismic stations. This is a much bigger network than that proposed by Stassen.

ACCESS TO TEST SIGHT OF INSPECTION TEAM

Let us discuss this problem of access to the suspected test site. If Russia is going to violate the testing agreement, she would also violate an agreement giving inspectors access to the suspected location. If Russia did not try to cheat, then the type of records I am thinking of would be of such a nature that the U. N. inspection agency would perhaps never get a strong indication of what looked like a secret explosion.

RAINIER TEST

I can use two examples here. One, the one known example of a deep underground, let's call it a hidden test. This was the 1.7 kiloton test Rainier. A Columbia seismologist and I sat down and put ourselves in the place of the head of this U. N. inspection agency, and just looking at the nonclassified records of this test, let us say specifically just those records by the United States Coast and Geodetic Survey, we tried to decide whether we considered this a strong indication of a bomb and not an earthquake.

Now looking at these records, there aren't too many of them, of the ones that are listed, there are eight stations which definitely received the direction of first motion. In all of these cases the direction of first motion was away from the suspected location.

I might point out that when people say what counts is not whether you can detect the test, and they refer to this 2,300-mile figure, but whether you can distinguish it from an earthquake, they should then point out that there were these eight stations that essentially did distinguish it from an earthquake.

The farthest such station was 520 miles away at Pinedale, Wyo. Well, we considered this as a strong indication, and we would then ask the nation concerned for permission to go to the site and investigate.

DEGREE OF ACCURACY IN IDENTIFYING LOCATION OF EXPLOSION

And furthermore we know we can pinpoint the location to within about 1 mile, and we would have no problem of telling that it wasn't an earthquake, once we were there, because the Atomic Energy Commission reports that that particular mountain suddenly lifted itself 6 inches, and we have seen movies in "See It Now" of how all of the rocks were disturbed.

It would just be a simple problem of observation by a geologist to tell that here was an underground explosion and not an earthquake. It would be a matter of a day to locate this.

Well, we would not know whether it was a chemical explosion or a nuclear explosion, but it should be part of the test-ban agreement that whenever a nation is going to do such a chemical explosion, that it announce it in advance and invite inspectors to the location.

POSSIBILITY OF ERROR IN DISTINGUISHING BETWEEN NUCLEAR EXPLOSIONS AND EARTHQUAKES

There is the reverse problem. What about earthquakes that come from that region of the United States? Would we ever call our shot wrong? Would an earthquake, ever look like an explosion to us?

Well, we looked up a technical paper by California Tech seismologists where they studied 16 successive local earthquakes greater than magnitude 5.

These earthquakes, every one of them had at least eight stations which gave a definite direction of first motion, and in every case there were at least two stations which gave the direction of first motion toward the site, so we never would have made a mistake on these natural earthquakes.

NUMBER OF EARTHQUAKES INSIDE LAND BOUNDARIES OF SOVIET UNION

I would like to point out our estimates of how many earthquakes are there inside the land boundaries of the Soviet Union equal to test Rainier or greater is on the order of 100 per year. So far the only technique I have been telling you——

Senator HUMPHREY. How many did you say, sir?

Dr. OREAR. About 100.

Senator HUMPHREY. Where do you get that figure?

Dr. OREAR. This is from study of both Russian papers and there is a book called Seismicity of the Earth, which gives a frequency of larger earthquakes in the Soviet Union prior to 1942, but it gives the total world figures or estimates for smaller earthquakes, and knowing what fraction of the larger earthquakes occur—they are many of these Russian earthquakes that occur just off the Kamchatka Peninsula, but under water. You are not going to test your bomb in the ocean. We are talking only of those on the land surface.

Senator SYMINGTON. Will the Chair yield at that point?

Senator HUMPHREY. Yes.

Senator SYMINGTON. Would you file a statement with the committee on that, because the figure you give for the number of Russian earthquakes a year is only a small fraction of the figure given to us in classified testimony. That is the type and character of thing we hope we can get released to the people. [The information requested is on pp. 1523 and 1524.]

Dr. OREAR. I mentioned this figure in the paper I submitted. Unfortunately this paper I submitted, I referred to this Livermore report for the magnitude of test Rainier. That said the magnitude was 4.6.

I have just recently learned the magnitude was 4.25. For 4.6 my estimate——

Senator HUMPHREY. Who said it was 4.6?

Dr. OREAR. The Livermore report, which I believe Senator Anderson was holding up.

Senator HUMPHREY. This is the one I have here, the underground nuclear detonation of September 19, 1957, Rainier Operation Plumb Bob.

Dr. OREAR. Yes, that gives the magnitude at 4.6.

Senator SYMINGTON. 4.6 what?

Dr. OREAR. This is the universal earthquake magnitude scale.

Senator SYMINGTON. You were not talking kilotons?

Dr. OREAR. No.

Senator HUMPHREY. It turns out to be 4.2, is that right?

Dr. OREAR. Your questionnaire, which we took to be the latest information on it, said 4.25, so we had to revise our estimates.

I had estimated about 50 earthquakes on the 4.6 basis, but on the 4.25 basis you will have to modify my report to read say around 120 per year.

I would like to point out that I am not a seismologist. A month or so ago I knew almost nothing about the subject. I have discussed this several times, and studied this problem with New York seismologists.

Senator HUMPHREY. Who is your chief seismologist at Columbia?

Dr. OREAR. The chief seismologist at Columbia is Dr. Jack Oliver of the Lamont Observatory.

Senator HUMPHREY. We sent out a number of questionnaires, as you know.

Dr. OREAR. Dr. Oliver received one. I believe he told me he was going to put a figure in of something like 100 per year for the answer to your question on how many inside the Soviet Union greater than test Rainier.

OTHER METHODS OF DISTINGUISHING EARTHQUAKES AND BOMBS

So far I have been talking only about one method of distinguishing an earthquake from a bomb, but I feel that there are other methods, and possibly these are classified, so it is probably not appropriate to talk about them.

But all of these methods combined, our feeling is that if Russia did not cheat on the tests, that we probably never would get a signal strong enough for us to ask permission—for us to claim, "Look, this looks like it was a secret bomb. We want to go in and investigate."

DEGREE OF INTENSITY OF EARTHQUAKES IN SOVIET UNION

Senator HUMPHREY. Is that because the earthquakes in the Soviet Union are of such a low intensity?

Dr. OREAR. Again I say this dividing line is in the kiloton region. The smaller earthquakes, say the magnitude four, you probably have to ignore completely, don't even bother looking at those records, so you are going to narrow down the study to on the order of 100 earthquakes per year.

The Russian seismologists have a large number of seismic stations right in the region where these earthquakes occur, so probably most of these will have on the order of 8 measurements of the direction of first motion, and just looking at this United States data, it appears very rarely, in fact we couldn't find a case where all 8 definite indications of direction of first motion were away from the source. Always there were at least two toward the source.

Now if you only have 4 stations giving this indication, of course then occasionally an earthquake will give all 4, but as you get a larger number of stations, this becomes much more improbable.

Senator HUMPHREY. And as you get closer in?

Dr. OREAR. Yes. So my impression of this plan to use the existing seismic stations gives us much more stations than any of us were originally thinking of, and it gives the highest density of stations in the regions where the earthquakes occur.

INSPECTION SYSTEM TO INSURE COMPLIANCE WITH TEST SUSPENSION AGREEMENT

My feeling right now is that this would be a quite workable system, and it would be very rarely that we would ask permission to investigate a site, or rather very rarely that we would get an indication of a violation. Probably if we had an indication of a violation, it really was a violation. In that case, Russia would not let us into the site anyway.

However, I do believe we should try to get as strong an agreement with as much inspection as possible, and if you can get it written into the agreement to have it be the right for these inspectors to investigate any location they want, this is all to the better.

But I think we should keep in mind if Russia does object to such an unlimited mobility of the inspectors, that this should not rule out all possibilities for a test ban agreement. If we have reservations about the uncertainties involved in underground detection, and the possibility that a very low yield test may escape positive identification, this first step agreement could ban only those tests which are detectable.

As I am pointing out, if that was the case it would cover everything that has been tested so far. It would cover any real prototype of a useful bomb.

MILITARY USEFULNESS OF BOMBS WHOSE MAGNITUDE IS BELOW KILOTON REGION

Senator HUMPHREY. That is a matter that will have to bear further examination I think. What were your exact words on a useful bomb?

Dr. OREAR. I am certainly not a military expert, but my feeling is that if you get to bombs in an order of magnitude below this kiloton region, you are already in a region of World War II chemical bombs, and I would tend to doubt that you are going to use nuclear explosives for those.

As I said again in this example of a hand grenade, what is the point of putting an atom bomb inside of a hand grenade?

Senator HUMPHREY. Again, I do not question your observations. I just point out for the record that we will want to bring this portion of the testimony to the attention of the weapons people that have testified before us, because when we get into design and make-up of these weapons, just as a layman, I must say that many of my previous notions about them surely have been changed a great deal because of the tremendous advance in technology. I do not say it is an advance for good, but it is surely a change.

Dr. OREAR. Yes. Well, when it comes to warfare I am a layman also. I do know that you can deliberately make a nuclear explosion as small as you want by making it inefficient, but in that case my feeling is you might as well be using chemical explosives.

SUSPENSION OF ALL BUT DEEP UNDERGROUND TESTS AS FIRST STEP AGREEMENT

Well, there are all kinds of possibilities for this first stage agreement. One possibility is to ban all but the deep underground tests.

In almost any kind of these agreements you can think of, there are what appear to be many advantages, and one advantage I would like to discuss a little further is that it prevents the spread of nuclear weapons to small nations. I believe that the present policy of our Government to give nuclear bombs to smaller nations is an exceedingly dangerous one.

Our study at Columbia has concluded that the main delivery system of these smaller nations, and perhaps of all nations, will be what we call the suitcase.

DANGER OF SPREAD OF NUCLEAR WEAPONS TO SMALLER NATIONS

Senator HUMPHREY. Doctor, we are going to have to recess to go over and cast a vote on the pending legislation. I would only say before we leave that this sentence on page 3 in your second paragraph, where you state, "The present policy of our Government to give nuclear bombs to smaller nations is exceedingly dangerous," that this is not yet a policy of the Government.

It is one which is being talked of, but at present we have nuclear weapons only in the hands of our own troops in other countries.

We have been negotiating such agreements, but as yet they have not been consummated. The question comes up of course as to the NATO Alliance, what reliance you place upon your allies in the NATO Alliance, and what weapons they are to have.

I am not drawing any value judgment. I merely state for the record that you get here into a very serious and important part of our NATO organization and what it really means in terms of the common defense. I think we should excuse ourselves, Senator Symington. We will be back to hear the balance of your testimony Dr. Orear. We have some questions we want to ask. You have been a very patient man. Thank you.

(A short recess was taken.)

Senator HUMPHREY. Dr. Orear, you have been, as I said earlier, most patient, and one of the most kindly witnesses we have ever had. We apologize for our short absence. Why don't you proceed with your prepared statement, and we will ask you some more questions?

Dr. OREAR. Yes, thank you. I was discussing our group's feelings about the spread of nuclear weapons to small nations.

In this interim I have learned of the proposed amendment to the Atomic Energy Act of 1954, the proposal given by the administration now, has been changed to restrict the number of nations. I am very glad to learn this.

USE OF SUITCASE AS MAIN DELIVERY SYSTEM

Our study at Columbia has concluded that the main delivery system of these smaller nations, and perhaps all nations, will be what we call the suitcase.

Senator HUMPHREY. What do you mean by that?

Dr. OREAR. Well, the bombs can be smuggled into a country. According to our studies, it is a simple technical problem to smuggle in megaton bombs into the United States, and to plant them around in various cities, and I would predict that within a few years every major American city will contain hidden H-bombs, and if I, and I am using

quotation marks about "I", were in charge of Soviet espionage, the bombs would already be here.

Suppose 5 or 10 years from now 30 nations have nuclear bombs, and suppose one of these hidden megaton bombs should go off here in Washington, leaving us with no administration or Pentagon. I wonder if you, Senator, have thought this out and decided just what should be our policy, just what should be done.

We might not even know with whom to retaliate. Thus our Government's great hope of security, massive retaliation, is fading away, and will become meaningless and useless in a few more years.

For example, this morning I read General Starbird's testimony, and to me some of the military ideas seemed obsolete. For example, clean warheads for antimissile missiles are no defense against the suitcase, and he never mentioned the suitcase method of delivery.

CONCLUDING REMARKS OF DR. OREAR

In conclusion I would like to point out that a workable inspection system for large-scale disarmament becomes technically more difficult each year. However, I would be glad to tell this committee about a new inspection technique worked out by our Columbia group, which looks powerful and workable, assuming only three nuclear powers.

Our proposed inspection systems become less workable as more nations get nuclear weapons. Now is perhaps the last chance for the world to adequately safeguard itself from nuclear devastation.

Senator HUMPHREY. Dr. Orear, I want to turn the questioning over at this time to Senator Symington.

Senator SYMINGTON. Thank you, Mr. Chairman.

MILITARY EFFECTIVENESS OF SMALL UNDETECTABLE NUCLEAR EXPLOSIVES

Doctor, I just have a few questions here. You said that the nuclear explosions that are so small as to be undetectable would not make practical weapons. On what do you base that statement?

Dr. OREAR. I also said that I am not a military expert in this field. I am just a layman.

The kind of thing I am basing it on is these type of weapons are so small in explosive power that they start to overlap with conventional weapons.

Senator SYMINGTON. I know. You don't say that in the statement, that you are not an expert. You say that inherently, and you release the statement. The statement here says that nuclear explosions so small as to be undetectable, in other words that is your opinion, is that right?

Dr. OREAR. Yes, sir.

Senator SYMINGTON. But it is not based on any experience, is it?

Dr. OREAR. It is not.

Senator SYMINGTON. In other words, would a weapon like this be good enough to shoot down an airplane?

Dr. OREAR. If I were shooting down an airplane, I would use a clean H-bomb in the megaton region. This only takes about 40 pounds of deuterium.

Senator SYMINGTON. Regardless of how you would do it, would a small weapon shoot down a plane?

Dr. OREAR. Well, in World War II we shot small weapons at planes and they usually were not very effective unless thay actually hit the plane.

Senator SYMINGTON. Let us not quibble because you know what we want to do is to get the truth out to the people. We could shoot down planes sometimes in World War II with little bullets, and you mentioned a 1 kiloton bomb here as a small bomb.

Therefore I think we both will agree, will we not, that you could shoot down an airplane with a very small nuclear weapon, and if you did not shoot down the airplane, the airplane might destroy your city. Would that be a fair statement?

COMPARABLE SIZE AND WEIGHT OF A 1-KILOTON AND 1 MEGATON WEAPON

Dr. OREAR. I would like to point out that a 1-kiloton nuclear weapon would probably be the same size and weight as far as the external size of the bomb or missile goes as the 1-megaton nuclear weapon, and they would both be of comparable radioactivity, so I would use a 1-megaton weapon to shoot down a plane, because then I don't have to hit it.

Senator SYMINGTON. Have you worked on weapons in any way yourself?

Dr. OREAR. No. My only military experience is a little over 2 years in the service.

Senator SYMINGTON. And you feel that a kiloton or a fraction of a kiloton weapon would be just as large as a megaton weapon?

Dr. OREAR. As far as physical dimensions, I won't say exactly as large, but fairly close to each other as far as physical dimensions and weight go, because 40 pounds of deuterium or 100 pounds of plutonium if completely used in fission is 1 megaton of TNT.

DISCOVERY OF TEST SITE AND VERIFICATION OF UNDERGROUND EXPLOSION

Senator SYMINGTON. Would you think that an inspection team if permitted to go to the site of an underground explosion would easily discover and prove that an explosion had taken place?

Dr. OREAR. I will say definitely in the case of Test Rainier that this would be simple, yes.

Senator SYMINGTON. How long did it take to discover the explosive aspect of Rainier?

Dr. OREAR. You have to wait until you get the seismic records together and do analysis on them. That might be a matter of a few weeks.

POSSIBILITY OF CAMOUFLAGING TEST SITE

Senator SYMINGTON. Why do the Russians have to refuse to let the inspection teams go and inspect? They might camouflage the site and thereby frustrate the efforts of the inspectors, don't you think?

Dr. OREAR. Suppose we tried to camouflage the site at Test Rainier? I think for a trained geologist this would be an impossibility, that we could not camouflage it. If a mountain moved up in the air 6 inches, I don't see how you can camouflage the effect.

CHARACTERISTICS OF SEISMOGRAPHIC RECORDS WHICH DISTINGUISHES NUCLEAR EXPLOSIONS FROM EARTHQUAKES

Senator SYMINGTON. Would you describe the precise characteristics which distinguish the seismographic record of a nuclear explosion from that of an earthquake?

Dr. OREAR. Unfortunately I am not a seismologist. It is my opinion that there is much more research than can be done on this to make the solution to the problem of detection much simpler.

I have the impression in talking with seismologists that actually perhaps a lot of research has gone into the detection of tests, but that to this particular kind of detection of tests, this seismic detection of tests, trying to distinguish them from earthquakes, I think little study has been done on this so far. It is a new subject.

I mentioned there is this definite way of distinguishing them by the direction of first motion. I can think of other possibilities such as the difference in the rise time of the initial P-wave, the possibility that earthquakes excite different types of waves than bombs can excite, the difference in radiation pattern. I list several other possible ways of distinguishing them.

Senator SYMINGTON. I understand that. We have had extensive and detailed testimony in classified hearings about the difference between the seismographic reactions of bombs and nuclear explosions, and of earthquakes, but I was just asking you the question if you could describe the precise characteristics which distinguish the seismographic records of a nuclear explosion from that of an earthquake?

Dr. OREAR. It is simple to describe, this one technique, the direction of first motion.

In the case of a bomb explosion, the ground is initially pushed away from the explosion, while in the case of an earthquake, one piece of ground is slipping against another piece of ground, so that in practice there are some places on the earth where the ground moves towards the earthquake, and usually about 50 percent of the stations that you have, the ground will initially move toward the earthquake, and it can never do this for a bomb.

EFFECT OF BAN ON ALL BUT UNDERGROUND TESTS UPON SPREAD OF NUCLEAR WEAPON INFORMATION

Senator SYMINGTON. Doctor, if we only ban nuclear tests carried out above the ground and permit testing underground, how would that check the spread of knowledge of nuclear weapons to other nations?

Dr. OREAR. Other nations could then test bombs underground, but we would know about it. I believe then the answer to your question would be——

Senator SYMINGTON. You say that underground detection at less than a kiloton. I might say in that figure you are very much lower than all the testimony we have gotten from all of the witnesses as to what could or could not be detected, but in any case we had a witness here earlier today who said they could test low yield in order to improve high yield if they did it underground.

Therefore I was just wondering if they could test any underground that could not be detected. How would that check the spread of the knowledge of nuclear weapons?

Dr. OREAR. My figure of about a kiloton is lower than others because I am using an additional 75 seismic stations in Russia. In the case of a nation, let us take France, for example, who is trying to develop an early simple-style bomb. There are many unknowns.

I would tend to think it is a difficult technical problem to build a first bomb which will definitely turn out to be below one kiloton. If you assigned me this problem, I might not be able to solve it for sure.

My first test would probably end up being quite a few kilotons, because the type of critical mass required in a crude bomb, let me point out if all of that mass was used in fission, suppose it was 10 pounds of plutonium, that would be a 100 kiloton bomb.

Senator SYMINGTON. When I asked the question of other witnesses, they did not get into the technicality of uranium or plutonium or strontium. I would like to keep it in a general way if I could.

You are a physicist and we are not. We are just laymen trying to get the truth.

My point is everybody agrees that there are certain sized bombs that can be detonated under the ground without detection. There is a big difference between what you think is the minimum size and what others do, but my question is if you can test them under the ground with the premise that that helps you develop bombs, what advantage do you have in making the test situation where you don't carry them out above ground and do underground. That was my question.

ADVANTAGES OF LIMITED TEST BAN AGREEMENT

Dr. OREAR. Yes, and your question also was referring to this particular advantage, does it really stop the spread of nuclear weapons to small nations, combining your two questions together.

My answer to this first advantage of stopping nuclear tests is that, to use France as an example, its first explosion I would guess would be many times greater than one kiloton. Now when I referred to one kiloton, I was referring to a fuzzy boundary between what you can detect and cannot detect. It means sometimes bombs somewhat greater than one kiloton you cannot detect and sometimes bombs smaller than one kiloton you can detect.

Now as for other advantages of this limited-type agreement you are referring to, you are now asking me about an agreement that bans all but the underground tests. This of course is not real disarmament. It does fairly little to slow down the arms race or the development of nuclear weapons, but it would be a first stage east-west agreement.

Also it would enable us to see what inspection is like for the first time to put inspection stations inside of Russia. This I feel is a very important accomplishment toward world peace.

Senator SYMINGTON. I want to say I think it is a good answer and I am completely in agreement with your statement and the position of Chairman Humphrey.

DESIRE OF ADMINISTRATION TO ACHIEVE DISARMAMENT AGREEMENT

It is unfortunate that there are backers of the situation from the standpoint of having nuclear testing only on a condition that we suspend production.

Don't you think that this administration—you may not agree with them in detail, but surely they would like to get a workable disarmament program if they could?

Dr. OREAR. I must admit this is a problem which bothers me. There seem to be some inconsistencies.

Certainly our administration is relaxing east-west tensions along some lines, but I am just guessing now, to quote from Dr. Teller's book. He said, "Disarmament is a lost cause." He sincerely believes this, and this means that other advisers of the administration will sincerely believe this.

It has been revealed in a speech by Robert Matteson that there is a competition in our administration between these two approaches, the relaxation-of-tension approach and the increased pressures approach, and my guesswork about this, and now I am speaking as an individual American citizen, is that our administration right now is afraid of a disarmament agreement. They feel it is too risky, you just can't trust the Russians that much.

Senator SYMINGTON. I think perhaps you take what Dr. Teller said in his book out of context. Could you find it in the book?

Dr. OREAR. When I read his book I read it in the galley proofs, it would take me a little while to find that particular place in his book. I can find it later.

Senator SYMINGTON. Would you do that?

Dr. OREAR. And insert it for the record.

Senator SYMINGTON. Based on his testimony today, I reread the last sentence of his book which impressed me:

> Rivals are men who fight over the control of a river. When the same word "rivals" comes to mean cooperation for the best common use of the river or any other resource—that will be the time of law and of peace.

I think he wants disarmament. He wants peace through disarmament, but he wants to be sure that it is a good workable plan.

Dr. OREAR. I would think with the rest of the context, his feeling right now is that disarmament is a lost cause, but that perhaps we can relax tensions in other areas than disarmament right now.

RISK OF VIOLATION OF TEST BAN AGREEMENT BEING DETECTED

Senator SYMINGTON. You speak of the awful consequences if violations were detected. What do you think would be the awful consequences?

Dr. OREAR. I speak of it being a risk to be detected as a violator. This risk is really a risk in the face of public opinion.

We have no world government, no way of punishing a violator. The only risk involved here is the loss of face in this propaganda battle, the loss of confidence of the peoples of the world.

Senator SYMINGTON. And that would be the awful consequence that you mentioned there?

Dr. OREAR. I don't think I called it an awful consequence, but this would be the consequence of violating the agreement.

Senator SYMINGTON. I was hoping that you did not mean that it might create an all-out war, because I certainly would not hope if they were caught cheating that we would immediately retaliate.

Dr. OREAR. I certainly would not advocate that.

METHODS OF USING SUITCASE BOMB

Senator SYMINGTON. As for the nation that placed the suitcase bomb into American cities or even many suitcase bombs in many American cities, in what precise fashion do you think the suitcase bombs would be used?

Dr. OREAR. In our Columbia Inspection Committee we had several evasion teams. In particular it is the report of Evasion Team No. 2 which I have not yet studied, which discusses this problem, but in general discussions with the people in our study, one possibility would be you need only have a small number of espionage agents in the United States, smaller than the number of bombs.

These agents can buy houses in various cities, and they can hide away these bombs in these houses, and then if they wanted to completely destroy the United States, it would take really just one man going around from one city to another pushing the button. The button actuates a time-delay mechanism, gives him time to get out of the city and fly to the next city.

USE OF SHIPS TO EVADE DISARMAMENT AGREEMENT

Senator SYMINGTON. I have always thought that one of the things they might do would be to have a lot of ships under separate flags, with false bottoms and drop them in the harbors and then have them go off together. That has always worried me.

That is another way along the same line as the suitcase business. But if that is true, why then any disarmament agreement is not worth very much, is it, from the standpoint of testing?

Dr. OREAR. This brings up a very important question, whether disarmament is foolproof or not.

Many years ago people were pointing out the urgency of getting disarmament now. They were saying if we don't get it within a year or two, it will be too late. In that sense it is already too late. But even at this late date our group has a workable inspection system.

IMPORTANCE OF RELAXING TENSION AS MEANS OF OFFSETTING RISKS POSED BY ANY UNACCOUNTABLE BOMB IN RUSSIAN STOCKPILE

I agree with your previous testimony that we cannot hope in a disarmament to account for all, or find all bombs that the Russians stockpile. They can successfully hide some of these bombs. Some of them may already be hidden in the United States. So there is now this risk. But it is a risk that is with us whether we have disarmament or not.

The ultimate solution for this risk is for a relaxation of tension between the United States and its enemies so that eventually our relations could be the way the relations are between the United States and Canada, where it is unthinkable to solve a dispute with Canada by means of military force.

Senator SYMINGTON. I think that is what Dr. Teller was getting at. It wasn't in his book, but it was in his broadcast, I believe, and he said:

DR. TELLER'S RESERVATION ABOUT PROSPECTS FOR MEANINGFUL DISARMAMENT

"I believe that disarmament is a lost cause. I believe that the course which we should pursue is to decrease the probability of war. In the long run I expect to eliminate the possibility of war by removing the will, not by removing the means. If you try to remove the means, you create the same kind of unstable situation which brought about the Second World War, where all the peace-loving nations disarmed and one cruel dictatorship ran away with the armament."

AGREEMENT ON SUSPENSION OF NUCLEAR WEAPONS TESTS, SEPARATE FROM OTHER PARTS OF WESTERN POWERS DISARMANENT PACKAGE

I agree with you. I would like to see us enter into a nuclear test suspension deal. There are a lot of problems in it, but it would at least give us an opportunity to break this curtain down.

We don't take to a deal unless we think it is the right deal, but at least we can talk about it and get going. I know the chairman has said that in his typically eloquent fashion several times, and with that I completely agree.

I do think it should be segregated from an overall complete package, especially after the testimony that we have had that part of that package would be difficult if not impossible, and I hope that Mr. Wadsworth and the State Department try to get a nuclear test suspension per se and not tie it into a lot of other things. With that I am in complete agreement with you.

What you say about the suitcase disturbs me because the suitcase problem is a problem that is going to be very hard to settle in a disarmament agreement.

EFFECT OF AGREEMENT ON CUTOFF OF PRODUCTION OF FISSIONABLE MATERIAL AND OUR RESPONSIBILITIES TO NATO COUNTRIES

As you know, we are under great pressure from NATO, in which we have a great many billion dollars and in which we also have a great deal of hope for these countries where you might say we "set them up" in the nuclear business as a way to defend themselves.

One fellow in Germany said to me last year, "We don't want to be liberated. We want to be defended." And they feel that they need this type of modern weaponry to defend themselves.

Where would you stand if you have a cutoff point? Wouldn't it be better to trust the whole world and get a brotherhood of agreement in this whole field, instead of trying to keep it to ourselves and not even give it to our friends?

Dr. OREAR. This concept of a nuclear bomb is a completely new and revolutionary idea. We must completely revise our thinking and try to think 5 or 10 years into the future as to all possible consequences of it.

This revolutionary idea is that in the palm of my hand I can hold enough plutonium to be a one megaton bomb, so it is very mobile, it can be hidden away, as I said, using the suitcase method of delivery.

The more nations who get this revolutionary new thing, the more chance there is that a place like Washington, D. C., will suddenly go up in the air. It could even be by accident, that these people who are sneaking bombs around, one of them could go off by accident.

Senator SYMINGTON. Doctor, I thank you. I would like to join the chairman in apologizing for being so late, but we had two votes, and it wasn't our fault.

Dr. OREAR. That is fine. I greatly appreciate the opportunity to express these views of mine and tell you some of the things that our Columbia group has learned.

IMPORTANCE OF SMALL WEAPONS

Senator SYMINGTON. I may say just one more thing. I hope sometime if you would come down here, if you are free, we could perhaps have lunch together. There is only one point that I just can't agree with you on, and that is that the small weapons are not mighty important.

One of the services doesn't care too much about them. The other two are awfully interested in them, and the whole theory of the pentomic division is tied up pretty close to things that can be carried by an individual. So if you would give me a chance sometime, we will talk about it and I will have somebody there who knows a lot more about it than I do.

One of the bitterest criticisms that I have heard of the Atomic Energy Commission, and I am sure the chairman has also, is their concentration on the superweapons as against the utilization of small tactical atomic weapons trying to hold wars down to what have been called by people like Dr. Kissinger conventional war.

EFFECTIVENESS OF SUITCASE AS PART OF DELIVERY SYSTEM

Senator HUMPHREY. Dr. Orear, I want to ask a few questions of you also. I surely do not have any expert knowledge about the weaponry department of the Atomic Energy Commission or the Department of Defense.

In fact, I never even wanted to know how many we had, never have asked the question. I just don't want to have the responsibility of having my memory affixed with that kind of data.

But I am concerned about your argument on the use of a suitcase as part of a delivery system, because while you can tell us that you can hold in the palm of your hand enough plutonium for a one-megaton explosion, that does not necessarily mean that you can perfect a weapon that would fit into a suitcase that would hold that plutonium, does it?

Dr. OREAR. No. If I were sneaking it into the country, I would not use the suitcase. I would go on a sailing trip and maybe have a rendezvous with some ship or submarine.

Senator HUMPHREY. What you are really getting at here, as I understand it, is that there are many ways to sneak weapons in.

Dr. OREAR. Yes.

Senator HUMPHREY. That is more dangerous than the cheating or sneaking on tests.

Dr. OREAR. And it is perhaps a more effective delivery system than our concentration on missiles and antimissile missiles.

In other words, this will revolutionize the concept of warfare. There is a thought barrier that we have to break through, and if you look a few years into the future, these to me seem to be the realistic things to think about.

Senator HUMPHREY. Doctor, there are many questions that I did not get a chance to ask Dr. Teller today, because I wanted to share this time with my colleagues—we are hoping to bring Dr. Teller and others, possibly yourself, back before our committee, because I have a whole book of questions here that I feel should be asked, and I shall get around to asking them at some time within the very near future.

CONFLICTING STATEMENTS REGARDING RADIOACTIVE FALLOUT

I want to discuss with you for a very brief moment the matter of clean bombs, and I use the word "clean" in the context in which it is used in discussion about these atomic or nuclear weapons.

Last week at his press conference the President indicated that an absolutely clean bomb was not possible. The President said that with respect to a proposal by Senator Case of New Jersey to limit tests to clean weapons:

> We must understand one thing in all honesty. We can call them clean weapons, but there is still a percentage of what you would call a dirty residual, and that has some effect.

The President indicated that he still hoped the weapons could be made cleaner. This hope, by the way, is expressed by all of our scientists.

General Starbird said before the subcommittee on March 12:

> I should emphasize that as of now we see no way of making a weapon completely clean, that is, clean to the extent that it has no residual activity.

On the other hand, Dr. Teller in his book, "Our Nuclear Future," states:

> I am placing only certain materials near the thermonuclear explosion. One may obtain a weapon in which the radioactivity is harmless. Thus the possibility of clean nuclear explosions lies before us.

Dr. Teller continued a few lines later by saying:

> Clean nuclear weapons will be the same as conveniently packaged high explosives. They would be nothing more.

As a physicist, I imagine it is within the purview of your theoretical as well as practical and applied knowledge to tell us why are we given so many apparently conflicting statements on the possibility of clean weapons.

POSSIBILITIES OF WEAPON WITH NO RADIOACTIVE FALLOUT

What is your view on this? Is it possible to get a clean weapon in so far as you and your colleagues in science know?

Dr. OREAR. There is first the technical problem of whether you can have a 100 percent fusion bomb, thermonuclear bomb, with no fission

trigger. Let us assume this is technically possible. I for one can't figure out how to do it. I would be a bit surprised if it could be done.

But even if it could be done, the fusion process gives you neutrons. These neutrons very quickly are absorbed by nuclei and this makes the nucleus, most of them, radioactive, so you do have radioactivity from the neutrons, and there is no way of getting rid of neutrons.

You might be able to reduce them appreciably by say using aluminum casings for the bomb. Then the neutrons absorbed in aluminum give short half life radioactivity which dies out in a few hours, but still there are the other components of the bomb.

There is the explosives which were used. There is the trigger mechanism, and then there is the air. All of these materials when they absorb neutrons can give also long lived radioactivity which we call fallout.

Senator HUMPHREY. So it is your view, as I understand from this very learned and scientific discussion, that it is difficult if not impossible, at least within present knowledge, to make a clean bomb?

COMPARATIVE AMOUNT OF FALLOUT BETWEEN 100 PERCENT FUSION BOMB AND 100 PERCENT FISSION BOMB

Dr. OREAR. Yes, that is my view. I would roughly estimate that a 100 percent fusion bomb is the equivalent to a 100 percent fission bomb, completely dirty bomb, which is one one-hundredth as large.

In other words, a ten megaton completely clean bomb is just as dirty as a 100 kiloton completely dirty bomb.

Senator HUMPHREY. In other words, as you get to the big monsters in the megaton class, even though you have fusion which is the process for the alleged bomb, they would still have as much radioactive fallout in them as smaller bombs of the fission type which would be in the kiloton class.

Dr. OREAR. The ratio I would estimate is roughly a factor of 100.

CONTROLLED CHAIN REACTION

Senator SYMINGTON. Could I ask a question there just for instruction? When you have a controlled chain reaction, you free neutrons, do you not?

Dr. OREAR. Yes.

Senator SYMINGTON. And you can have a control chain reaction which becomes an uncontrolled chain reaction. In that case you sort of have lost control of your neutrons, is that a fair statement?

Dr. OREAR. Yes, that is.

Senator SYMINGTON. Then if you can go from controlled to lack of control, couldn't you control your explosion to some extent in the fusion process going toward cleanness by setting up type and character of materials so that you had limited lack of control?

Dr. OREAR. Yes, if I were doing it with my limited knowledge, I would make the bomb casing out of aluminum. I would use as much aluminum as I could. But there is a lot of material in there that won't be aluminum, and that material will give long-lived radiation.

Senator SYMINGTON. Mr. Chirman, I would like to suggest that this is one point I would like to hear a little classified discussion on from

those who think you can get a clean bomb. When they say "clean", it doesn't mean entirely clean.

EFFECT OF USING WEAPONS WITH RADIOACTIVE FALLOUT AS DEFENSE AGAINST BALLISTIC MISSILES

But what worries me is if you don't have a clean bomb, I don't see how you can have an adequate defense against ballistic missiles, unless you want to spray fallout over your own people. So it would be very interesting if we could have discussion on that, Mr. Chairman, between experts.

Dr. OREAR. I think I can answer that question in your mind. If you attack the missile above the earth's atmosphere, in the stratosphere, then this radioactivity takes on the average of 10 years to fall down and falls down all over the entire earth, so any individual person who gets it, gets quite a small amount.

Senator HUMPHREY. But don't you have three types really of fallout, the local fallout, the tropospheric, and the stratospheric?

Dr. OREAR. Yes, but if our antimissile missile exploded in the stratosphere, then it will give only the stratospheric fallout.

CLEARANCE FOR AND DECLASSIFICATION OF CLASSIFIED INFORMATION

Senator HUMPHREY. Dr. Orear, has anyone from the Atomic Energy Commission consulted with you in recent days relating to some of the statements that you have been making in the papers which you have presented?

Dr. OREAR. No member of the Atomic Energy Commission. These are the types of things that physicists talk about with fellow physicists, and certainly I have talked with many physicists, some of whom work on classified projects or have worked on classified projects, but they do not give me any classified information, and I would not want them to.

Senator HUMPHREY. Have you had any type of clearance at all?

Dr. OREAR. Not really. I have had clearance, the highest level clearance I have had is that which is required to ride in a military airplane, MATS.

Senator HUMPHREY. You had to have clearance for that?

Dr. OREAR. I don't know why.

Senator SYMINGTON. Could I ask a question, Mr. Chairman?

Senator HUMPHREY. Yes.

Senator SYMINGTON. Your testimony is impressive. We have had a lot of testimony that is impressive from people who, in the main, have not been cleared for classified information. Most of the people who disagree with your position have been cleared for classified information.

From the standpoint of what is best for the people, don't you agree that it would be a good idea to declassify every possible amount of material that we are discussing, to bring you all in and show you and then to declassify what they say and what you say, so that we can have the whole story right on the books and form a decision based on everybody's opinion?

Dr. OREAR. I heartily agree with this, and I imagine there would be no disagreement among us at all as soon as we could talk to each other and tell each other what we have in mind.

Apparently somebody who has classified information has told you some number that disagrees with my numerical estimates. If the two of us could get together freely, inside of an hour or two we would be in complete agreement.

Senator SYMINGTON. Mr. Chairman, I think that is about as good a statement as we have had before the committee.

Senator HUMPHREY. You have been here a long time, Dr. Orear. We are going to conclude this session today, but I hope that you will feel that you want to come back to us again if we need you, and we may very well want to call upon you. We welcome any of the studies that you and your group make.

I understand Columbia University has done a study on radioactive fallout as well, is that not true?

Dr. OREAR. Yes, especially the aspects of using radiation as the means for inspection for violations of a disarmament agreement.

Senator HUMPHREY. Has that material been made available to the subcommittee?

Dr. OREAR. This I do not know. We have a preliminary draft of our report which was circulated to a limited number of people. I do not know whether you have one of these preliminary drafts, but we can give you a final draft within about a week.

Senator HUMPHREY. Wonderful. Please share with us your findings and your suggestions.

CLEARANCE OF DR. OREAR TO RECEIVE CLASSIFIED INFORMATION

Senator SYMINGTON. May I ask one more question? We are going to have Admiral Strauss tomorrow. Might it not be a good idea to ask him to clear you all who feel this way, in order that you can get together so that you can have these discussions and declassify as much as possible, or at least give us a joint opinion, even if it has to be in executive session. Would you agree to that?

Dr. OREAR. For Admiral Strauss to——?

Senator SYMINGTON. In other words, let's get people like you and Dr. Brown cleared right away so you can go in there and discuss this whole question of the danger of testing, which is the basis of the testing program, and which in turn is the basis of disarmament progress. Then you could discuss these things on a completely "Here is all the information" basis with those people who are cleared. From that we could get a consensus of opinion which would really mean something.

Dr. OREAR. I would much prefer it if some of this crucial information could be cleared, if the information could be cleared rather than me being cleared.

If I were cleared, I would not be able to give you the public testimony that I have given you. I would not be able to talk about this fuzzy dividing line being in the region of a kiloton. You saw how the previous witness was quite handicapped.

The advantage I have now is that I can discuss many of these things freely in the open public and open press, and I think there must be some people who still have this freedom, and I have found this to be a considerable advantage, in order to serve this purpose.

Senator SYMINGTON. It is a tremendously interesting observation you have made there. On the other hand, it would appear from what you say that if you worked for the Government, that is an automatic way of preventing the people from getting the facts. Is that a fair interpretation?

Dr. OREAR. I would say that if I had this clearance, that then I would not be able to talk about many of these things in public and present some of these facts to the public.

Senator SYMINGTON. Mr. Chairman, I would like to see the record on that tomorrow and have the Chair discuss that with Admiral Strauss.

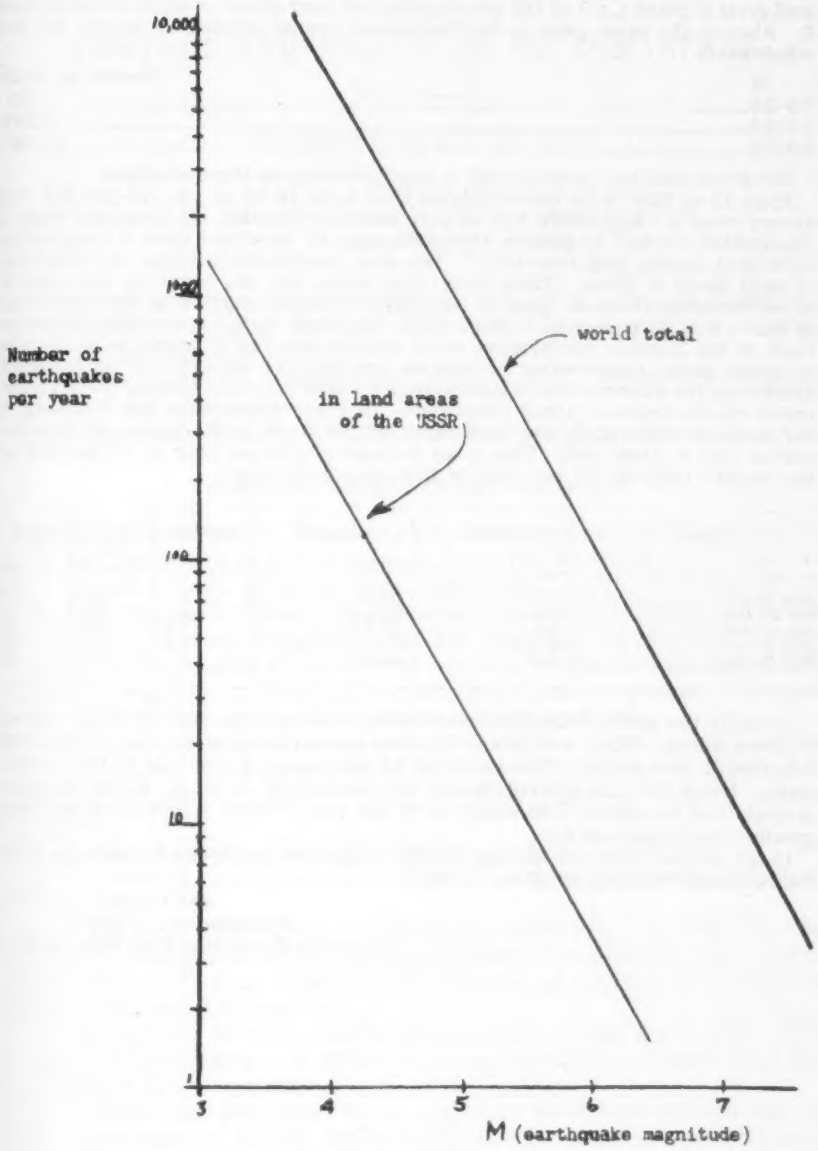
Senator HUMPHREY. Before we recess, I want to note for the visitors who are still here with us at this late hour that in our audience is Mr. Northrup of the Department of Defense, who has received an outstanding civilian service award within the past few days. We want to congratulate you, Mr. Northrup. I thought we might just as well do it publicly as privately, informally, as well as formally.

I think that concludes today's session. Thank you, Dr. Orear.

(Whereupon, at 6:30 o'clock p. m., the subcommittee adjourned to reconvene on Thursday, April 17, 1958, at 10 o'clock a. m.)

APPENDIX A

EARTHQUAKES IN LAND AREA OF U. S. S. R.



This graph is based exclusively on the data in "Seismicity of the Earth" by B. Gutenberg and C. F. Richter, Princeton University Press, Princeton, N. J., 1954.

Table 3 on page 18 of this book is entitled "Mean annual number of shocks" and gives a grand total of 127 earthquakes per year above or equal to magnitude 6. Also on the same page is the "estimated annnal number of shocks for the whole earth:

M	*Number of shocks*
5.0–5.9	800
4.0–4.9	6,200
3.0–3.9	49,000"

My graph entitled "world total" is based entirely on these numbers.

Page 11 of this same book explains that table 13–18 on pp. 133–288 list "all known class a (magnitude 7.75 to 8.5) shocks, 1904-1952, all identified class b (magnitude 7.0 to 7.7) shocks, 1918–1952, and all identified class c (magnitude 6.0 to 6.9) shocks, 1932-June 1935." The date, magnitude, latitude, and longitude of each shock is given. Thus from these tables one can count up the number of earthquakes above or equal to magnitude 6 which occurred in the land areas of the U. S. S. R. from 1932 to June 1935. The word "land" is mentioned because most of the Russian earthquakes occur underwater and it would be a mistake to count them (underwater explosions are easy to detect). A seismologist answering the subcommittee's questionnaire would normally include these underwater shocks unless warned otherwise. In these tables only the following 5 earthquakes occurred in the land areas of the U. S. S. R. during the 3.5-year period 1932 to June 1935. This is an average of 1.43 per year or 1.1 percent of the world's total of 127 per year in this magnitude range.

Date	Latitude	Longitude	Meridian	Page No.	Shock No.
June 10, 1932	52.5 N	142 E	6	228	700
Oct. 29, 1932	39.5 N	72 E	6	233	300
Jan. 3, 1934	52.8 N	156.6 E	6.9	268	870
Aug. 31, 1934	38.75 N	71 E	6.5	233	300
Nov. 18, 1934	54 N	160.5 E	6	194	580

Actually the period 1921–1941 has the highest frequency of U. S. S. R. entries in these tables. There are 59 earthquakes equal to or greater than magnitude 6 in this 21 year period. This would be 2.8 per year or 2.2 percent of the world's total. Using this 2.2 percent figure, the number of U. S. S. R. earthquakes greater than magnitude 4.25 would be 92 per year. There would be 46 per year greater than magnitude 4.6.

In my opinion these are the best possible estimates which can be obtained from the reference "Seismicity of the Earth."

JAY OREAR,
Department of Physics,
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CONTROL AND REDUCTION OF ARMAMENTS

THURSDAY, APRIL 17, 1958

UNITED STATES SENATE,
SUBCOMMITTEE ON DISARMAMENT OF THE
COMMITTEE ON FOREIGN RELATIONS,
Washington, D. C.

The subcommittee met, pursuant to call, at 10 a. m., in room 457, Senate Office Building, Senator Hubert H. Humphrey (chairman of the subcommittee) presiding.

Present: Senators Humphrey (chairman), Byrd, Symington, Wiley, and Hickenlooper.

Also present: Senator Clinton Anderson, of New Mexico.

OPENING REMARKS OF THE CHAIRMAN

Senator HUMPHREY. Yesterday the Subcommittee on Disarmament received testimony in public session from Dr. Edward Teller and Dr. Jay Orear. Both of these men contributed to the subcommittee's study of proposals for an international agreement to suspend nuclear weapons tests with inspection and the proposal for a cutoff of production of fissionable materials for weapons purposes with inspection.

Many questions still remain concerning these proposals. We need more information about these most pressing problems.

In continuing this current series of hearings, we are very pleased to have scheduled for this morning Dr. Hans Bethe, who will be heard in executive session, to be followed by Adm. Lewis L. Strauss in public session.

Our first witness is Dr. Han Bethe, professor of physics of Cornell University, and a member of the President's Science Advisory Committee.

Dr. Bethe is one of our outstanding scientists. In 1947 he was named a consultant to the Atomic Energy Commission; and served from 1943 to 1946 as chief of the theoretical physics division, Los Alamos Science Laboratory.

From 1942 to 1943 Dr. Bethe was member of the staff of the MIT radiation laboratory. In 1944 he joined the Office of Scientific Research and Development.

Dr. Bethe has requested to be heard in executive session but he has also consented to edit his remarks so that some of his testimony may be made public.

Dr. Bethe, we are very pleased that you could come and talk to the committee. I shall proceed now knowing that some of my colleagues cannot be here for the moment because they are trying to get quorums for other committee meetings.

We want you to know that this record will be reviewed by every member of our subcommittee and our staff carefully, and what you have to say will be of utmost value to us.

THE EFFICACY OF INSPECTION

I hope you will speak very candidly. As I tried to indicate in yesterday's session, and others, we haven't any party line or any position about these matters. We are trying to seek information. I work on this proposition: That if the President and the Secretary of State, as our spokesmen in the field of foreign policy, are advocating a beginning disarmament agreement on the cessation of nuclear tests and the cessation of production for weapons purposes with international inspection, then it is fitting and proper for those of us who may be called upon to ratify any such agreement, if such is made, to know about the efficacy and the adequacy of inspection, whether or not inspection can really work.

Now we have never suggested there could be a "100 percent foolproof" inspection system. That would be desirable if it could be obtained, but we have been told that that is not a possibility or a probability. The decision relating to inspection must involve several factors, not merely the scientific factors, but also, of course, the political and the moral considerations, the worldwide public opinion considerations. At all times we are greatly interested in our own national security.

Now the question is, can you have a test suspension with international inspection without jeopardizing our national security? That is really what it boils down to. So with that as sort of a preface, I want you to give us the benefit of your wisdom and your experience in this field.

I want you to know that every member of this committee is deeply indebted to you and others like you for the patriotic and devoted service that you give the country.

I speak for every member of this committee when I say that.

STATEMENT OF DR. HANS BETHE, PROFESSOR OF PHYSICS, CORNELL UNIVERSITY

Dr. BETHE. Thank you very much, Senator.

I entirely agree with you that you should have the best information, and I shall try to do my best to tell you what I know. [Deleted.]

Senator HUMPHREY. And you are on Dr. Killian's Committee?

Dr. BETHE. I am on Dr. Killian's Committee. I am, however, not testifying on behalf of that committee. My knowledge about the subject in question comes from my long association with Atomic Energy Commission laboratories and committees of the Atomic Energy Commission, and the Department of Defense.

Senator HUMPHREY. I understand that. Will you proceed now? As I understand it, you are going to give us some of your views and observations [deleted].

DETECTION OF ABOVE-GROUND TESTS

Dr. BETHE. [Deleted.] I have had occasion to know about the methods for finding out foreign tests. [Deleted.]

It would be desirable to be able to detect much lower yields because the low yield bombs are quite important, and so a system has been devised, including stations in Soviet Russia, which if accepted by international agreement, could lower the threshold of detection. [Deleted.]

Senator HUMPHREY. You are speaking now of surface explosions?

Dr. BETHE. Of surface explosions, surface or low in the air.

Senator HUMPHREY. Yes; substratosphere, in other words.

Dr. BETHE. Yes. This involves [deleted] stations, mostly for observing acoustic waves, that is, small changes of barometric pressure which fluctuate, and also to detect electromagnetic signals from explosions.

It is my opinion that if you have such a net, you would be really in a very good position to detect surface and low air bursts [deleted] and that you could identify them even without collecting radioactive debris.

I believe this would be possible to our own satisfaction.

CONVINCING NEUTRAL COUNTRIES

Now it would be a different matter to convince neutral countries. I don't know to what extent neutral countries would be convinced by a set of signals which we considered perfectly unique in indicating an atomic explosion.

To convince neutral countries it may be necessary to collect debris.

Senator HUMPHREY. In other words, your feeling is, Dr. Bethe, that the neutral countries would not be satisfied?

Dr. BETHE. They may not be satisfied.

Senator HUMPHREY. With the acoustical and electromagnetic observations?

Dr. BETHE. Yes.

Senator HUMPHREY. They might want the radioactive debris testing as well.

Dr. BETHE. Yes.

Senator HUMPHREY. They might feel that our judgment on this without radioactive debris might be prejudiced; is that the point?

Dr. BETHE. That is correct.

Senator HUMPHREY. Come in, Senator Hickenlooper.

Dr. Bethe has just been discussing with us a possible detection program. [Deleted.]

And he has pointed out that under this program, explosions, on the surface and at lower altitudes, down to a rather low yield could be detected.

Dr. BETHE. And identified.

Senator HUMPHREY. And identified.

Dr. BETHE. Yes.

Senator HUMPHREY. Even without radioactive debris collection.

Dr. BETHE. Yes; identified to our satisfaction.

Senator HUMPHREY. To our satisfaction.

Dr. BETHE. And I then went on to point out that this may not be to the satisfaction of some neutrals, and that if we want to satisfy the delegates from India, for instance, we may have to show radioactive debris. [Deleted.]

Senator HUMPHREY. That is without even detection stations in Russia; is that what you mean?

Dr. BETHE. I would say that is after we have detected an acoustic and electromagnetic signal. [Deleted.]

If we want to collect radioactive debris from very small tests, then it would be necessary to have the right to overfly parts of Russia in case [deleted] acoustic and electromagnetic systems detect such a test. [Deleted.]

Senator HUMPHREY. You could ascertain the radioactive part of it by flights around Russia, not overfly them.

Dr. BETHE. Yes.

Senator HUMPHREY. But if you got down to a very small yield, you would have to have overflight rights?

Dr. BETHE. Yes.

Senator HUMPHREY. Which would mean international inspection rights within the Soviet Union?

Dr. BETHE. That is correct.

TESTS AT HIGH ALTITUDES

Now this is the normal way of testing atomic weapons, which has been used almost exclusively. I now want to discuss the question of testing atomic weapons in unusual places. There is one possibility of going to extremely high altitude, of going to let's say 100,000 feet or more in altitude. [Deleted.]

We have done quite a lot of theoretical investigation on the signals which you would receive from a high altitude test, and it is my conviction that such a high altitude test could be detected and could be identified if we had a net of stations within the Soviet Union. [Deleted.]

Senator HUMPHREY. Senator Symington, Dr. Bethe is just now describing for us some of the problems relating to detecting weapons at unusual levels.

He has discussed with us the surface and the lower altitude testing and detection, and has outlined a program which he believes would satisfy our requirements. [Deleted.]

Now he is discussing for us detection of high altitude bursts.

Senator HICKENLOOPER. One hundred thousand feet. [Deleted.]

Dr. BETHE. [Deleted]. If we come to an agreement on test cessation, we should put into this agreement a clause permitting the testing at high altitude, and in order to prevent that this be used for the development of weapons, one could stipulate that this be done only with stockpile bombs set aside for the purpose at the beginning of the agreement.

This is my personal proposal, and is not in any way accepted by anybody else.

Senator HUMPHREY. I see; but you are making a very important point here—that we do not have adequate information at the present time on high altitude explosions.

[The ensuing discussion, which is deleted, referred to the possible detection of high-altitude tests.]

Senator HUMPHREY. Dr. Libby spoke to me a little bit about the variety of tests that will be undertaken by this country in the summer series. The important information to be obtained from these tests is one of the reasons that I felt that we ought to get some of us on this committee on record for the continuation of the test series that comes up in May and June, because these tests may be very important to our national security and to science itself. [Deleted.]

SECURITY INTEREST IN CONTINUATION OF TESTS

Senator HICKENLOOPER. I may say, Mr. Chairman, parenthetically, that it is not necessary to get me on record. I have been on record for a long time as to the vital necessity of the continuation of these tests in the interests of our very security.

Senator HUMPHREY. I understand.

Senator HICKENLOOPER. I am glad to have this evidence.

Senator SYMINGTON. Senator Hickenlooper, may I ask you, does that include tests beyond these tests?

Senator HICKENLOOPER. Oh yes.

Senator SYMINGTON. Are you saying then that you don't think there is any chance of negotiating a suspension of tests after these tests?

Senator HICKENLOOPER. Oh no. I hope the time may come when we can with safety and within the light of all our information feel some reliance on agreements on cessation of tests, but we are not at that point now, in our own interests.

Senator SYMINGTON. And you do not think we will be for some time?

Senator HICKENLOOPER. I am no scientist.

Senator SYMINGTON. But I am asking you as a member of the Joint Atomic Energy Committee.

Senator HICKENLOOPER. As a matter of fact, with this series of tests that is coming off now, we will learn a great deal. We will take a long step at least toward learning some of the answers that we want to know [deleted] about the chemical and physical reactions of improved weapons and explosions. I think we will have to abide these tests this summer and then take a look at it from there. Have we learned enough or do we have to go a step further?

Senator SYMINGTON. That is what I was asking.

Senator HICKENLOOPER. I think we must go to the point where we have at least reasonable assurance from the scientific standpoint that we have adequate answers before we get into a finalized agreement of some kind.

I think it is just in our own interest, our own security. [Deleted.]

Senator WILEY. It is your mature judgment and the judgment of your associates in this field that in the interests of national safety tests must go on for the time being.

Dr. BETHE. I would like to defer my opinion for a little while. I think that one particular type of test, namely, for effects of high-altitude shots may have to be conducted in the future.

I want to talk later on on my general opinion about test cessation, if you will permit me.

Senator HUMPHREY. Thank you. Go right ahead.

POSSIBILITY OF SOVIET "CHEATING"

Senator SYMINGTON. May I at the risk of redundancy ask a couple of quick questions?

Doctor, we had a young man, Dr. Jay Orear, say yesterday that any test above 1 kiloton could be detected, in his opinion. Dr. Teller felt that any test below a certain level would not be detected necessarily, and that that might increase the problem, based on the preparations and the plans that the Russians made to see that they could cheat successfully.

In fact, Dr. Teller felt if they really made extensive plans, that they might very much increase the size of the bombs that they could test underground and not be caught. Perhaps you have already explained this to my colleagues, but could I ask how you feel about that?

Dr. BETHE. I was just coming to that. I wanted to say about the high-altitude tests that I feel very well assured that a system of stations inside Russia would detect high altitude tests [deleted]. This is a separate problem from the one of whether we should continue such tests. But I think on the basis of theoretical estimates, I believe that [deleted] signals from high-altitude tests are [deleted] so characteristic that we would surely detect high-altitude tests at any altitude with a system of stations within the Soviet Union.

DETECTION OF HIGH-ALITUDE TESTS THEORETICAL

Senator HICKENLOOPER. And yet, Doctor, we must prove that with our own tests. I mean we must produce the proof.

Dr. BETHE. We certainly should produce the proof.

Senator HICKENLOOPER. Instrumentation and detection ability.

Dr. BETHE. Yes.

Senator HICKENLOOPER. What you are saying is theoretical at the moment.

Dr. BETHE. This is entirely theoretical.

Senator HICKENLOOPER. I just wanted to make that clear.

Senator HUMPHREY. But you are separating two things. You are saying at least from theoretical knowledge, and which we will verify in tests, that you believe you can detect high-altitude tests?

Dr. BETHE. Yes. [Deleted.]

Senator HUMPHREY. If you have an international agreement which provides stations within Russia.

Dr. BETHE. That is correct.

Senator HUMPHREY. But that does not mean that you are advocating necessarily the cessation of tests at high altitude.

Dr. BETHE. That is correct.

Senator HUMPHREY. Primarily because, as you have indicated, that tests may be needed for other purposes.

Dr. BETHE. Right.

Senator HUMPHREY. I mean scientific purposes.

Dr. BETHE. Yes. [Deleted.]

Senator HUMPHREY. We are talking about an international agreement that includes stations within Russia. In these discussions we are not talking about a unilateral cessation at any time.

Dr. BETHE. That is right. [Deleted.]

UNDERGROUND NUCLEAR TESTS

Underground explosions, as you already know, are a very difficult thing to detect and identify because the normal methods of detection, acoustic, electromagnetic, and radioactive, do not work at all.

If you make an underground test, you see to it very carefully that no radioactive material will escape, so you will not catch radioactive debris. In the nature of things you will not get acoustic and electromagnetic signals. You will only get a seismic signal. Now the seismic signal is not very well known because we have had only one single underground explosion, the so-called Rainier shot of the last Nevada series, and from one example it is awfully difficult to make any conclusions on the next in other surroundings and with other yields of the nuclear weapon.

IDENTIFICATION OF RAINIER SHOT

Senator HICKENLOOPER. In fact, Doctor, we had some testimony on that by the seismographic people who said if they had not known that at that particular instant an underground shot had gone off, they could not have identified it on the seismograph as an atomic explosion, or differentiated it from just an ordinary earthquake.

Senator HUMPHREY. They did not testify to that in this committee. I want to make the record clear. They testified to that beyond certain distances, but when you got up to 350 miles——

Dr. BETHE. That is correct.

Senator HICKENLOOPER. I think if you will get the record—I looked it up—where they testified in the Foreign Relations Committee room before this committee, I asked that very question.

I said, "Could any of these stations have identified that as an atomic explosion had they not had the information that it had gone off at that minute?" and the answer was a flat "No," and there were two questions to that. But knowing that it went off at a certain moment——

Senator SYMINGTON. Putting it this way, Bourke, knowing that it was going off at a certain moment.

Senator HICKENLOOPER. Yes; and many of these stations did not detect it until after they went back and checked their records, knowing that it had gone off, and then they found the wiggle there.

Senator HUMPHREY. But the truth is that they didn't know because the tests were changed 2 or 3 times, according to Dr. Libby, who was in Paris at the time telling the Russian scientists that the test was going to go off at 6 o'clock or something on such and such a date, and then it didn't go off, and then it didn't go off the next time.

Senator HICKENLOOPER. I suggest we get the transcript.

Dr. BETHE. Senator, may I make my own remarks to this? I hope to clear this up.

It is indeed very difficult to tell an earthquake from an underground explosion. It is possible to do so in many cases, but not in all cases.

SEISMIC RECORDS ON RAINIER SHOT

In the present case in the Rainier shot itself, it was a great help that the test had been announced. From the records of the near stations I

think one could have identified this explosion even if one had not known that such a test was to go off.

Let me explain this in detail. The present stations in California are not as good stations as can be made, as good seismic stations as can be made. [Deleted.]

Nevertheless, in the records of the near stations, there is a very clear signal which I have seen myself. [Deleted.]

The pressure wave which arrives has a first impulse which corresponds to a compression of the earth, whereas if you have earthquakes, then the pressure wave, the initial pressure wave, sometimes corresponds to a compression and sometimes corresponds to an expansion of the earth.

CHARACTERISTICS OF EARTHQUAKES

I should explain that in more detail. If you have an earthquake, then the normal thing is that in 2 quadrants you get an expansion of the earth, so that if you surround the site of the earthquake on 4 sides by stations, then from an earthquake you will get a compression record in 2 directions and an expansion record in 2 other directions, whereas if you have an underground explosion, you will get a compression record in all 4 directions.

This is the basis of the suggestion [deleted] for a system of seismic stations in the Soviet Union to detect tests.

COMPRESSION RECORDED IN ALL STATIONS EXCEPT ONE

Now we do not have such a complete system surrounding the Nevada test site, but, nevertheless, in the stations which we do have, the record was unmistakably a compression in all stations but one. In this one station the record was not clear, and it was not clear because the signal was not strong enough, and this has to do with what I said before, namely, that the stations are not terribly good [deleted].

The trouble is that every seismic station has a lot of noise in its seismogram, and it happened in this station that the noise was about as big as the signal received from the Nevada Rainier shot. Now you can reduce the noise considerably by proper design of the station [deleted]. If you have a net of stations so that you are within about 300 miles from any conceivable test site and from any conceivable earthquake in the seismic regions of Russia, that then you can make sure what the first signal is. So I believe, Senator Hickenlooper, that this is somewhat intermediate between the statements which you have made.

FOREKNOWLEDGE AND SEISMOGRAPHIC IDENTIFICATION

Senator HICKENLOOPER. I wasn't discussing the point as to whether you could eventually detect. I am talking about the machinery that we now have set up and all these talks about our detecting underground tests.

Dr. BETHE. Yes.

Senator HICKENLOOPER. And I submit that the evidence which we received, I have it here, there are three places, indicated that without the certainty, that is without the knowledge either that a test was going to be had at a certain moment, or later that it had been had at a certain

moment, the so-called wiggles on the seismographs would not have identified it independently as an underground explosion.

Once there is the verification, the knowledge that an explosion had occurred, then they can say "There it is, this is the wiggle on the seismograph," but independent of that knowledge, the evidence I think is clear, and I am going to look it up here.

EXPLOSION IN URAL MOUNTAINS

Senator HUMPHREY. How did they detect this explosion 5,000 miles away in the Ural Mountains on March 25 in the Soviet Union?

Dr. BETHE. By seismographs.

Senator HUMPHREY. They did not know that the Soviets were going to explode it?

Senator HICKENLOOPER. I was going to get into that a little later when we get to the seismograph people. I do not know, but I have an impression that they could not identify it necessarily as an underground explosion. They suspected that it might have been an underground explosion because an earthquake had not occurred in that area for 40 years, and that raised a question: Is that an explosion or is it an earthquake after 40 years?

Dr. BETHE. That is precisely right.

Senator HICKENLOOPER. Yes. Then when Russia verified that they had exploded it, they said, "We caught the wiggle on the seismograph."

Dr. BETHE. They caught that wiggle unannounced.

Senator HICKENLOOPER. That is right.

Dr. BETHE. And this is somewhat pertinent.

Senator HICKENLOOPER. That is right.

Dr. BETHE. And the explosion was a few kilotons, and the wiggle was caught unannounced, and since it was in an aseismic region——

Senator HICKENLOOPER. But the point is that is not a reliable method of determination at the present moment.

Dr. BETHE. I agree absolutely.

Senator HICKENLOOPER. We had an earthquake down in Kentucky, as I understand, in about 1875. They never had had an earthquake in that area as long as they had been keeping records, and it closed up a valley and they have never had an earthquake there since.

Dr. BETHE. I agree absolutely.

Senator HICKENLOOPER. So the fact that an earthquake hasn't occurred in an area for 20, 40, or 50 years does not mean that another one is not going to occur next week.

Dr. BETHE. It seems geologically very rare that in the middle of an aseismic region you get an earthquake, but of course occasionally you may do so. [Deleted.]

IDENTIFICATION OF URAL EXPLOSION

Senator SYMINGTON. I want to be very sure that I understand this. What Senator Hickenlooper says intrigues me. We would not have been able to say that we detected anything in the Urals beyond our belief that it was probably an earthquake, if it had not been for the fact that they announced an explosion; is that correct?

Dr. BETHE. We had the very strong evidence that there never had been an earthquake in this region.

Senator HICKENLOOPER. Forty years, I think.

Dr. BETHE. Yes.

Senator SYMINGTON. Then if that is true, you could extrapolate that we would never be able to say that we had discovered a test for sure unless it was corroborated by their statements.

Senator HUMPHREY. Oh, no.

Dr. BETHE. Or by other evidence.

Senator SYMINGTON. I am only talking about this particular case, this particular sized bomb, this particular distance.

Dr. BETHE. Yes.

Senator SYMINGTON. I am not saying that if we were sitting next to it and saw it go off we wouldn't know, but I am talking about this particular test.

Dr. BETHE. This particular case.

Senator SYMINGTON. Which got a great deal of publicity.

Dr. BETHE. Yes.

Senator SYMINGTON. In my opinion, the publicity helped the people who want us to stop testing and hurt the people who do not want us to stop testing.

As I get it there would have been no way for us to have known anything about that Ural explosion unless we had been told something about it by the Russians.

Dr. BETHE. There would have been no way to be absolutely sure.

VERIFICATION UNDER AN INTERNATIONAL AGREEMENT

Senator HUMPHREY. Dr. Bethe, may I ask this: If you had an international inspection agreement and you had picked up this wave on your seismograph stations and there had been no earthquake in this area for 40 years, and you picked up a very definite wave which indicated some sort of earth movement, what would you do? You would go and inspect?

Dr. BETHE. That is right.

Senator HUMPHREY. Now that is the point. You cannot talk about this in the present circumstances. All that I said in this release was an effort to identify what had happened, which I thought the AEC should have released itself, was that there had been an interception of a seismographic wave.

Senator SYMINGTON. Hubert, I am not talking about any release you made.

Senator HUMPHREY. That is what I released. All I am saying is had you had an agreement with the Soviet—here is an area where for 40 years there had never been an earthquake. Suddenly there is an earth movement which is recorded on seismographic stations. If you had an international agreement, that would have been the alert to go and see whether or not they had violated it.

Senator SYMINGTON. I think that makes good sense.

Senator HICKENLOOPER. I think that is something to do.

Senator SYMINGTON. I do, too.

PREVIOUS TESTIMONY ON RAINIER SHOT

[Discussion deleted. Senator Hickenlooper referred to previous testimony that not a single seismograph could have identified the Rainier shot with reasonable positiveness as an underground explosion if it had had no notice that an underground explosion had occurred.]

Senator HICKENLOOPER. That is my understanding. Now I do not say that we won't perfect this. I am not arguing that we can never do this, and I am not a scientist. I do feel at the present time I don't want us to be misled in the country that we can today with verity and reliability say positively that some oscillation on a seismograph is an atomic or underground explosion.

Senator SYMINGTON. I would like to ask a question there. The premise of our effort is to try and find a path for a nuclear test agreement, and with that premise then the apprehension is whether or not they could cheat after the agreement was made, the way we wanted to see it made.

Dr. BETHE. Yes.

Senator SYMINGTON. Now if we have the agreement made the way we would like to see it made, with the stations and so forth that have been set up as the way to do it, do you still feel that they could cheat, and if so, down to what sized bombs?

DISTINGUISHING EARTHQUAKES FROM EXPLOSIONS

Dr. BETHE. I will come to that in a minute. I would like to say something to the argument which has just been going on. It is true and will remain true that we can never be 100 percent sure from the seismic record alone that an underground explosion has taken place, and this is certainly true particularly if the test explosion were set off in a seismic region.

If the Russians were to test in the Kamchatka Peninsula, or in the foothills of the Himalayas, where there are hundreds of earthquakes every year, then it would be far more difficult to tell these earthquakes from underground explosions.

On the other hand, one distinguishing feature of underground explosions [deleted] is the distinguishing feature of the first signal, whether it is compression or expansion. [Deleted.]

An individual seismic station can never tell whether there is an earthquake or an explosion from its record.

Senator HUMPHREY. The individual station.

Dr. BETHE. The individual station cannot tell. However, an inspection system could put a complex of stations around each possible explosion site. Thus, when you look at the signals from the entire system and find that all of them have a compressional first motion, then you would strongly suspect an explosion, and this way we could eliminate most of the earthquake signals.

"DOUBTFUL" EARTHQUAKES

Now there will still be a significant number of signals even with this first compressional wave identification, that will be sufficiently doubtful that we will have to send inspection teams. [Deleted.]

Let me explain just a moment what I mean by "doubtful." Earthquakes are never reasonable. They produce strange patterns of compressions and rarefactions around them. It is not a clean-cut quadrant where these are all positive and these are all negative. You will find in your positive quadrants where you will have 3 or 4 out of perhaps 15 that will be negative, and you start to worry why were they negative. Therefore, in the Rainier case, which Senator Hickenlooper mentioned, there were something in the order of 8 or 10 stations, I believe, I don't recall the exact number, within about 250 miles. There was one station out of step in that region.

INVESTIGATION TEAMS FOR SUSPICIOUS SHOCKS

Looking at that close-in Rainier data, you would strongly suspect that it was an explosion, since let's say 9 out of 10 of the stations were compressional. But that one station would still worry you somewhat, and you would not know but what if you had had a better distribution of stations around Rainier you might have picked up a few negatives. You would strongly suspect it enough so that you would report to your headquarters, your inspection headquarters, something suspicious had occurred, and you would certainly want to investigate that spot for further confirmation.

The seismic system can never give you 100 percent proof, but with the system involving stations relatively close in, I believe that we could eliminate a substantial majority, bring it down to a reasonable size, and inspection teams could then follow up on the questionable items.

DIFFERENCE OF INITIAL MOTION IN EARTHQUAKES AND BLASTS

The method of distinguishing between earthquakes and blasts from an analysis of the direction of the initial earth motion depends on the hypothesis that earthquakes are caused by faulting, the slipping of two layers past each other. If this hypothesis is correct, earthquakes will radiate initial compressions in some directions and rarefactions in other directions. An explosion, on the other hand, will radiate initial compressions in all directions. This method of identification is not foolproof, however, for the following reasons.

First, Sutton and Berg of Columbia University have shown in a recent publication that earthquake faulting may occur under circumstances where the rarefactions are not observable except at very small distances—of the order of 100 miles—and they conclude that the resulting earth movement may be compressional in all directions as expected from an explosion.

Second, there is also some doubt that all earthquakes are caused by faulting. Many Japanese seismologists feel that other mechanisms may be involved as well. John Hodgson of the Dominion Observatory of Canada has published a review of the results from many earthquakes studies. He found that, while a high percentage of large earthquakes can be explained as being caused by faulting, it frequently happens that this explanation does not seem to be adequate.

Senator SYMINGTON. What is your point?

Dr. BETHE. The point is that when I said an earthquake always produces positive in one quadrant, negative in another, positive in another and negative in another, there are some cases that this gentle-

man in Canada is studying right now in which he believes some of these earthquakes he is looking at may have produced positive in all directions which would make them look like explosions.

Senator HICKENLOOPER. Produce the compression impulse.

Dr. BETHE. Right.

Senator HICKENLOOPER. In all directions.

Dr. BETHE. Yes, sir. It was with these factors in the back of the seismologists' minds, who testified before you, that made it difficult for them to give you a black or white answer.

COUNTRY SHOULD NOT BE MISLED

Senator HICKENLOOPER. I am not arguing against improving the detecting systems. I merely want to keep the perspective correct as to what the situation is at the present time.

If we are going to talk about getting into agreements as to the cessation of tests, I do not want the country and everybody else to be misled into thinking we have a foolproof system of absolutely telling if the Russians cheat on the deal, because I don't think we have it.

Senator HUMPHREY. Dr. Bethe, you said that not a single station as a single station could have identified it.

Dr. BETHE. Right.

Senator HUMPHREY. But a system could have given you a reasonable clue.

Dr. BETHE. You would have had a reasonable clue and you would have reported the epicenter looked rather peculiar.

Senator HUMPHREY. And you advocate that in an inspection and detection program not to rely on a single station but a system of stations in areas particularly where there are seismic movements; isn't that right?

Dr. BETHE. That is right.

Senator HUMPHREY. So that let's say in the Himalayas at the base of which you said, Dr. Bethe, there are a number of earthquakes—it would be in this sort of an area, if you had an international inspection system, where you would want to establish a number of inspection stations, would you not?

Dr. BETHE. That is right. [Deleted.]

DIFFERENCE BETWEEN PRESENT AND PROPOSED DETECTION SYSTEMS

Senator HUMPHREY. I do not think there is any argument here. I think what Senator Hickenlooper is properly saying is that under present, available, in-being detection, that it would be exceedingly difficult to ascertain an underground explosion, and that you surely would not want to rely upon what we presently have.

With this I would surely concur. The other part of it is that if you did have an agreement which provided an international inspection with a system of seismic stations plus the right to make an on-the-spot observation and inspection in case there was something that appeared on the seismic record which indicated an unusual disturbance, that this would have within it the elements of a reasonably effective inspection apparatus or detection apparatus. [Deleted.]

I think there is no difference except I do think we have to keep emphasizing that what we presently have is not what we would have

to have if we were ever going to enter into any kind of an agreement relating to the cessation of tests.

Dr. BETHE. Precisely.

Senator HUMPHREY. You have to have much more.

Senator SYMINGTON. I would like to add, if I might, one point there. That everything down to a point can be detected and then as the blast or the power of the bomb decreases, then detection becomes less certain.

Dr. BETHE. That is right.

Senator HUMPHREY. More difficult.

Senator SYMINGTON. And that to me is very important based on some testimony from Dr. Teller yesterday.

Dr. BETHE. Yes, I want to come to that.

Senator SYMINGTON. In which he said that you could make tests on relatively very small powered bombs which would give you the information necessary to further develop your much larger-powered bombs. In other words, you could test small kiloton bombs and in that way work out what you wanted for megaton bombs.

Dr. BETHE. I will come to this.

Senator HUMPHREY. I think we should let Dr. Bethe continue now.

Senator SYMINGTON. I just wanted to make sure that that point was brought up, that we haven't got what we need in order to make a deal at this time, and any deal has the weakness derived from using small weapons from the standpoint of detection, is that right?

Senator HUMPHREY. The degree of certainty of detection goes up with the size of the bomb. The degree of certainty of detection goes down with the smaller size of the bomb.

Senator SYMINGTON. That is right.

Senator HUMPHREY. Dr. Bethe, you go right ahead and I think all of us will restrain ourselves until you have completed your testimony.

Dr. BETHE. I believe that a set of seismic stations in both the Soviet Union and China is necessary for a good detection capability for underground bursts.

I include China, even though it would be much more difficult to reach an agreement with China than to reach an agreement with the Soviet Union, and even the latter is certainly difficult. [Deleted.]

NUMBER OF EARTHQUAKES IN THE U. S. S. R. AND CHINA

The 1.7 hiloton underground blast, Rainier, was detonated in volcanic tuff, a relatively porous material which considerably reduced the amount of energy transmitted to the earth from that which would have been expected had the test been detonated in solid rock. It is assumed that any attempt to hide an underground test would utilize a similar insulation for purposes of concealment. The frequency of earthquakes in the U. S. S. R. and China of magnitude equivalent to that produced by underground explosions of given yields has therefore been estimated on the assumption that the coupling between the bomb and the earth is similar to that realized in the case of the Rainier shot. The estimate is also based on the assumption that the scaling to sizes larger than Rainier will be similar to that observed on quarry blasts in a range from 0.2 kiloton to 8 kilotons equivalent TNT. Statistics are based on data in Seismicity of the Earth, Gutenberg and

Richter (1954), corrected to agree with revisions to the earthquake magnitude scale (Gutenberg 1956).

On this basis it is estimated that about 2,500 earthquakes per year of magnitude 3.9 (1 kiloton) or larger will occur in the U. S. S. R. and China each year. Of these 2,500 earthquakes about 2,150 will lie between magnitude 3.9 (1 kiloton) and magnitude 4.9 (5 kilotons), about 210 will fall in the range between magnitude 4.9 (5 kilotons) and magnitude 5.3 (10 kilotons); about 120 will fall in the range between magnitude 5.3 (10 kilotons) and magnitude 6.2 (50 kilotons) and the remainder, about 20 earthquakes per year will be of magnitude 6.2 (50 kilotons) or larger.

These estimates are of course rather crude, and it will require observations of several underground nuclear explosions of differing sizes to confirm them. One point seems rather clear, however, and that is that over 1,000 earthquakes per year will produce seismic waves larger than those from an explosion equivalent to Rainier. It should also be emphasized that it will be necessary to have ground teams inspect only a certain fraction of these as well as some of the smaller earthquakes, because the others will have been identified as earthquakes from the seismic evidence.

Now these numbers are based on the assumption that the explosion is made in volcanic tuff, which gives you a relatively small seismic signal, but on the other hand, we do not know whether there are not some rock formations which will give you an even smaller seismic signal, and it is here that Dr. Teller comes in and tells you that the seismic signal in some surroundings, in some rock formations, may be still a good deal smaller than what was observed in the Nevada test site. We simply do not know the answer to this, and we will not know the answer to this unless we experiment on this.

And here again I personally would say that if we have a test cessation agreement, then the inspecting agency probably should conduct experiments, further experiments, on the seismic signals which are obtainable from explosions of various size in various surroundings.

UNDERGROUND TESTS TO DETERMINE SEISMIC SIGNALS

Now Dr. Teller and a number of other people who are very strongly against test cessation will argue that a country which is insistent on violation of the test agreement can defeat the inspection system by conducting underground tests in surroundings where you get a very small seismic signal.

My personal opinion is that this will be true only to a very limited extent, and if a country is intent on defeating a test cessation agreement and violating it, then it will have to conduct a lot of experiments underground with low-yield weapons to find out whether seismic signals from these are detectable.

It is my opinion that this would be a very dangerous game for them to play and that somewhere on creeping up on the yield they would be detected.

It is Dr. Teller's opinion that they might get away with it, and this is simply a difference of opinion. Neither of us, I think, has a very firm basis for it. I am convinced that somewhere there would be a slip and the inspection system would detect a test if such a series were conducted let's say by the Soviet Union.

Now what about the size of tests that we could detect? [Deleted.]

Of course, the seismic signal will pinpoint the location of the suspected place [deleted] and I believe it will be a great help that most of the areas which have great seismic activity are trackless areas, are areas in which there are not even roads, so that if the inspection team gets there, it will not find even a road on which a testing team might have gone in, and this would simplify the activities of the inspection agency.

If they do find roads, they would have to follow every one of them and try to find an entrance to a tunnel.

Senator HICKENLOOPER. Of course, if there were no roads in there, I suppose they still have helicopters.

Dr. BETHE. They might have.

Senator HICKENLOOPER. I mean if a country, I submit, is bent on cheating on this thing, they would go to great lengths to establish the greatest possible difficulty in either detection or later inspection.

Dr. BETHE. Absolutely.

Senator HICKENLOOPER. If they follow that policy, then there is no detail that they would omit knowingly to pull the curtain down.

Senator SYMINGTON. I couldn't agree with you more. I will give you one quick illustration of that.

In England in 1941 just north of Birmingham, they had the Bolton-Paul plant, and they were terrified that the Germans were going to destroy it. So they built a phony plant about 5 miles off and they carefully left a bucket on the roof or something in order that it could be seen by a good camera. That plant was destroyed five times by the Germans. The plant that they really did camouflage was never touched. That is the type and character of thing you are going to get into if they are going to really want to cheat.

PENALTY OF "CHEATING"

Senator HUMPHREY. Of course, when they cheat, then all bets are off.

Senator SYMINGTON. Then you get a question of who says they cheated and did they cheat.

Senator HUMPHREY. I think one of our witnesses testified that you have never designed a law yet that has not had somebody that violated it, but you pay a penalty for the violation. I mean there is no assurance, may I say, if I am going to argue the point, that we are even ahead of the Russians today, but somebody comes in here and testified that we are.

There is no absolute assurance that it will work.

Senator SYMINGTON. I think you and I are in complete agreement that we want to try to do our best to get a cessation of nuclear testing if we can do it without affecting the security of the United States.

What I am worrying about is whether we can ever get a sound system. I want to try to get it. However, if it is not a sound system, then it is the American people who lose and not the Russians, because we are not going to blast Moscow off the face of the map because they cheated. The people who lose are ourselves.

QUESTIONS ARISING FROM TEST BAN PROPOSAL

Senator HUMPHREY. That is right. What I am trying to get at all the time is this—and I am going to be very blunt about it—why are the President and the Secretary of State talking about the cessation of tests, if it is all this hazardous? I am going to be very open about it. What are we doing? What is this?

Senator SYMINGTON. What is the use of packaging cessation of testing with the question of cessation of production when a person of Dr. Teller's standing comes up here and talks the way he did yesterday about the difficulty of detecting production and the impossibility of detecting stockpiling? If you throw the nuclear testing in with those other two you may be really kidding the people. That is what has me worried.

Senator HUMPHREY. What I am worried about is if it is this hazardous, if the Soviet leaders are as sneaky, as subtle, and as clever as we always say they are, then they must have one blind spot. If it is this hazardous, they should have bought this a long time ago.

I just cannot understand how they have let us get by this long.

We have been parading around here all the time with a package in our pocket saying, "Sign it and we will deliver." We had a man in London for months on this basis.

Well, now, if it is this hazardous, I cannot understand why this wily Khrushchev hasn't said, "I will take that because we are going to cheat on those characters. We have got those nice noble men all tied up in the United States. They are going to be honorable, decent, and truthful. We are going to be sneaks and cheats. We have got them signed up. We will cheat them while they pray."

That is just the way it adds up. So I think there must be something else to it, that is all I am saying.

EVIDENCE OF UNDERGROUND TESTS

Dr. BETHE. Senator, I am not sure whether I am quite as pessimistic on the detection of these underground tests. For one thing, I do not know how well you can do with helicopters without leaving tracks. If the inspection team has access to the place, I think they will find something. [Deleted.]

I think they might get away with 1 or 2 tests that way. I think they would hardly get away with a whole series of tests, and certainly not with a whole series of tests at one spot, but even at various spots I think the chances of finding out about an underground test are considerable. If they do it by roads, which is by far the easier way of conducting a test because, after all they have to transport quite heavy equipment, you probably will find some evidence, and if they do it by helicopter, I think they have at least to walk over the ground. You have to have, however, complete access and immediate access for an inspection team to any suspected area, and I think without that the inspection system would be useless.

IMMEDIATE ACCESS REQUIRED

Senator HUMPHREY. Then we come to the possibility that the Soviet Union might delay. They are past masters at this foot-dragging business.

Dr. BETHE. Yes.

Senator HUMPHREY. At that point they could put up all kinds of arguments and obstructions. I think this has to be carefully considered.

Dr. BETHE. Yes. The package, whatever inspection agreement, if such an agreement were negotiated, would have to imply immediate access without further negotiations, and the team would have to have the right to go to the spot, to the suspected spot right away when the seismic signal is found.

INSPECTION OF CURRENT NUCLEAR PRODUCTION AND STOCKPILES

As far as the inspection of production is concerned, if I may digress for a moment to that, there is a plan which was worked out by the agency which set up the international pool for nuclear reactors, and this agency was very concerned about diversion, about the use of fissionable material produced in these reactors for illicit purposes, and they worked out a plan which now exists to inspect plants, production plants, in such a way as to make impossible or very difficult the diversion of any appreciable amount of newly produced fissionable material.

On the other hand, if it comes to stockpile, then I entirely agree with Dr. Teller that it would be extremely difficult to ascertain that material from weapons stockpile is returned to peaceful purposes.

On this I see no way, no good way of doing it. But making sure that current production is not diverted to weapons I think is not a difficult task because you can find the plants even though they are not advertised, and you can certainly, once you are in the plants, you can certainly find out where the material goes. For current production I think there is not much difficulty. For past production, I think it is impossible, or nearly impossible.

Senator HICKENLOOPER. I would think that would be perhaps a good, sound analysis of the thing. From my viewpoint tracing production in plants would be comparatively simple. It would not present much difficulty, but I do not know how you could be sure you had the stockpile all tabbed.

Senator HUMPHREY. I think there is pretty general agreement on that as to the stockpiles. You would have to rely on the word of somebody to give you an inventory, and that would be a rather hazardous pursuit in this business.

Senator HICKENLOOPER. I think we have, within reasonable limits, that is, reasonable variable limits one way or the other, plus or minus, a fair idea of about what they have, but then of course if they are over by 15 percent rather than under by 15 percent of our estimates, that 15 percent could do at lot of damage.

Dr. BETHE. Yes.

Senator HICKENLOOPER. If they wanted to use it. We would just have to take their word for it, I think.

Dr. BETHE. Yes.

Senator HUMPHREY. What you are saying is that from the day that you arrived at an agreement, it would be possible to supervise, inspect, and detect current production.

Dr. BETHE. Yes.

Senator HUMPHREY. Is that your testimony?

Dr. BETHE. That is my testimony.

POSSIBILITY OF DIVERSION

Senator SYMINGTON. I am not sure of that. I have been a manufacturer for a great many years and I have run into organized groups of people who could steal a tremendous amount of production materials. In fact, in one plant I ran a group set up another plant. We thought we had the thing pretty well controlled. They made radio sets in another plant in another part of town with the pieces they consistently took out. I don't think you can say that absolutely, but there again that is a risk that I think we would take.

Dr. BETHE. Senator, I think you cannot say it absolutely, but I think it would be very difficult to divert as much as 5 percent.

Senator HICKENLOOPER. I think there are ways and means in addition to physical contact and knowledge where if they are producing this we would find out about it.

Senator HUMPHREY. Go right ahead, Dr. Bethe. [Deleted.]

Senator HUMPHREY. Doctor, do you feel that our design, variety, and stockpile of weapons is superior to the Soviet Union today?

Dr. BETHE. I certainly do, but the Soviet Union has a satisfactory system. [Deleted.]

ADVANTAGE OF TEST CESSATION AGREEMENT

Senator HUMPHREY. Then if it were possible, and I qualify that with a big "if" in light of the testimony we have had in the last couple of days, if it were possible to get an agreement which would provide access of inspection teams to doubtful areas, I mean areas where the monitoring stations indicated tests might have occurred, would it be to our advantage or their advantage in your mind to have such an agreement?

Dr. BETHE. To our advantage, in my mind.

Senator HUMPHREY. Very much to ours, or only modestly?

Dr. BETHE. Considerably to our advantage. I feel that if testing continues, then they will surely attain the same level of capability as we, and I feel that it is just a matter of simple logic that for the relative standing it is more advantageous to stop when you know that you are still ahead.

Senator SYMINGTON. Mr. Chairman, may I ask a question there?

Senator HUMPHREY. Yes.

Senator SYMINGTON. If we are ahead, as you say, then of course it is to our advantage to stop testing now. But, if we are ahead and we stop testing and they are behind and agree to stop testing, but do not, then of course they would rapidly overtake and pass us with respect to the development of weapons; is that a fair statement?

Dr. BETHE. If they continued testing and we stopped it, they would certainly catch up and overtake us.

However, it is my belief, as I have said, that they could not substantially improve their capability without a tremendous risk of being detected.

Senator SYMINGTON. Then the question of an agreement gets down to a recognition on their part and our part of the advantage to us in making it, and also the importance to us of being sure that they cannot cheat, is that a fair statement?

Dr. BETHE. That is correct.

Senator SYMINGTON. And inasmuch as you have analyzed it probably as much as any man around, how do you feel, what do you think we should do now in your personal opinion?

Do you feel we should enter into a cessation of test agreements with these people?

Dr. BETHE. That is my opinion, provided they agreed to a good inspection system with all the trimmings that I have outlined, and I should like to add that the inspection system in itself would be of value, because it would to some extent open up Russia and help to reduce tension between the two countries.

Senator SYMINGTON. Do you think there is any necessity for that test suspension to be tied up with the question of the cessation of production?

Dr. BETHE. No.

Senator SYMINGTON. Thank you, Mr. Chairman.

POLITICAL DESIRABILITY OF INSPECTION SYSTEM

Senator HUMPHREY. I have tried to make the same point that you have just raised, Dr. Bethe, that getting the inspection system on its own, regardless of the testing, would be a political advantage.

Dr. BETHE. Yes.

Senator HUMPHREY. It would be politically desirable.

Dr. BETHE. Yes.

Senator HUMPHREY. I have also felt that when the Soviet spokesmen have mentioned that they were prepared to negotiate an international inspection system it has been my feeling that we should probe them to find out just what they mean. I am quite convinced in my own mind that they are going to do a lot of foot-dragging, that it is going to be very difficult. But we will never find out what they are talking about, and will never really be able to give them the political litmus paper test until we try it. They keep talking about international inspection, but the last experience we had on that was Korea, and that was anything but a heartening one.

I am of the opinion that we ought to be pushing them and find out what they really mean, and in the meantime try to get international teams under the UN working on all of this detection apparatus system as much as we can. That has been my personal view about it.

Dr. BETHE. Yes.

Senator HUMPHREY. Do you agree with that?

Dr. BETHE. I entirely agree. I should like to add about the inspection system that apparently there are a lot of seismic stations already in Russia. If they were to admit international inspectors to the existing stations, this might be a start.

Senator HUMPHREY. It would be possible, would it not, also to consider negotiating an agreement along the lines that some others have talked about, I mean with certain limitations involved, on weapons size or on radioactive yield.

Dr. Libby talked to me about one proposal he had.

Dr. BETHE. Yes. There is one point, however, which I consider very dangerous. It has been proposed to test only underground, to permit mainly underground tests. I have heard that proposal from many sides. This I consider not a solution of our main problem because our main problem is to stop their development. [Deleted.]

DANGER OF COMPLACENCY

Senator WILEY. What makes me hesitant, I had an experience last year before sputnik. I went to Europe and I talked with a number of officials in other countries.

They were sitting back pretty complacently. Then sputnik arrived and complacency went out the window. We thought we knew.

Now there is one other thing. You are talking about tests in the so-called nuclear field.

Dr. BETHE. Yes.

Senator WILEY. Is it possible that because of the German scientists that the Russians have had and their own scientists, that out of their own investigation they have developed a lot of knowledge relating to their ability to take over the world if they want to, that we do not know about? For instance, sputnik came into the scene without our knowing it.

Dr. BETHE. I don't believe that the German scientists did them very much good on the atomic scene. I think this is all Russian. They certainly did them some good in developing missiles. [Deleted.]

SHOULD CALL SOVIET BLUFF

Senator WILEY. You know that Secretary Dulles had considerable trouble trying to get an agenda.

Dr. BETHE. Yes.

Senator WILEY. And now you think that the Russians are playing in good faith when they want to get together and agree to discontinue tests?

Dr. BETHE. I have no idea. They may or they may not. They certainly did their best to put us on the spot. They tested at a terrific rate, at an unprecedented rate during 1958 in order to be finished with their tests before we would start, and of course they knew when we would start. So from this point of view it is very likely that they did it, they might have done it just for propaganda purposes.

On the other hand, I agree with Senator Humphrey that we should find out whether they mean it or whether they are just——

Senator WILEY. You mean call their bluff?

Dr. BETHE. Call their bluff.

Senator WILEY. See if they will come through.

Dr. BETHE. Yes.

Senator WILEY. With an agenda on inspection, that is what you mean.

Dr. BETHE. That is what I mean.

Senator WILEY. Just one other thing in relation to this whole matter because I see a distinguished citizen, Admiral Strauss, sitting in back of you and I might ask him whether up to date on my questioning he agrees with Dr. Bethe's answers.

Admiral STRAUSS. I would like to have it more specific, Senator Wiley. I do not agree with all of my good friend Dr. Bethe's answers, and he wouldn't expect me to. I yield to Dr. Bethe on technical questions. On matters of judgment I suspect that he would agree that my position had perhaps as much validity as his. I, for example, feel that test suspension at this time would be a disadvantage to us.

Senator HUMPHREY. You mean after the May and July series?

Admiral STRAUSS. Yes, sir.

Senator HUMPHREY. You mean after this summer it would still be a disadvantage?

Admiral STRAUSS. It would be a disadvantage to the defenders to stop their production and development of defensive weapons, because they have to be more sophisticated than the weapons of attack, but I do not want to take Dr. Bethe's time.

SHOULD CONDUCT PRESENTLY SCHEDULED TESTS

Senator WILEY. You have answered my next question, because I understood before you said that we should carry on our present tests.

Dr. BETHE. Yes.

Senator WILEY. Until we had gotten the information that those tests would give us, and then try to get an agreement and an adequate enforcement agreement. Am I right?

Dr. BETHE. You are entirely right. I say that I am all in favor of carrying out our present tests to the end and in getting an enforcible agreement to take effect thereafter. I would say, however, that I would be in favor of starting negotiations on such an agreement earlier, but not to stop our present series.

Senator WILEY. Thank you very much, sir.

Senator HUMPHREY. I surely want to thank Dr. Bethe. Do you have other material that you would like to present to us now, Doctor?

Dr. BETHE. No. [Deleted.]

UNDERGROUND TESTS IN CHINA

Senator HUMPHREY. Do you think we can have a really effective inspection agreement, Dr. Bethe, without including China?

Dr. BETHE. We would certainly be in a position to detect tests in China to some extent. We would have a hard time identifying any underground tests in China if that is what we want to do.

Senator HUMPHREY. This is what has been bothering me. As you know, I indicated from totally unclassified material in Soviet publications that the Russians directed and conducted in China underground tests.

Now they most likely were chemical but we don't know, but they were of tremendous power.

Dr. BETHE. We know.

Senator HUMPHREY. An almost unbelievable amount if it was chemical.

Dr. BETHE. Yes.

Senator HUMPHREY. And what I worry about is whether or not the Soviet might not use China as a sanctuary for this underground testing in light of the difficulty that we have in ascertaining the underground tests unless you can go in as you indicated earlier on the spot immediately.

Senator Byrd has been very kind to come. He is one of our real experts in the whole field of the armed services as well as finance.

Senator BYRD. Thank you. I have no questions at this time.

Senator HUMPHREY. We are very grateful for your attendance.

Senator WILEY. What about underwater tests? Suppose you go down 5 miles, what then?

Dr. BETHE. They are quite easy to detect. [Deleted.]

Senator WILEY. I remember coming over on the *Queen Elizabeth* and the ship went over like this and I said to the captain, "What is the trouble?" He said, "I think we had an earthquake about 5,000 miles away."

Dr. BETHE. Yes, water is a very fine medium to transmit a shock.

Senator WILEY. If there is an underwater explosion, why couldn't it be mistaken for an earthquake?

Dr. BETHE. This shows that disturbances are very easy to detect, but you would have to rely on other means to find out what country conducted it.

Senator WILEY. They have broken 50 out of 52 agreements with us already.

Senator HUMPHREY. Dr. Bethe, I think that we are going to let you go. We are exceedingly grateful to you, and your testimony has been very informative, very helpful, and all I can say is that the Government of the United States is mighty lucky to have you as one of its servants and I want to thank you from the bottom of my heart for all that you are doing for us. I feel better when I talk to men like you.

Dr. BETHE. Thank you very much, Senator.

Senator SYMINGTON. I would like to associate myself with those remarks.

Senator WILEY. We all agree with the conclusion of the chairman.

Senator HUMPHREY. This testimony, of course, is in executive session and we will be discussing with you, Dr. Bethe, and your associates, what we will do about it. I think there are portions of it which would be readily made available but there are other portions which obviously you do not want to make available.

(Whereupon, at 12:05 p. m., the subcommittee adjourned.)

CONTROL AND REDUCTION OF ARMAMENTS

THURSDAY, APRIL 17, 1958

UNITED STATES SENATE,
SUBCOMMITTEE ON DISARMAMENT OF THE
COMMITTEE ON FOREIGN RELATIONS,
Washington, D. C.

The subcommittee met, pursuant to recess, at 12:15 p. m., in room 457, Senate Office Building, Senator Hubert H. Humphrey (chairman of the subcommittee) presiding.

Present: Senators Humphrey (chairman), Byrd, Symington, Wiley, Hickenlooper, and Bricker.

Also present: Senator Clinton Anderson of New Mexico.

Senator HUMPHREY. The committee will come to order, please. The first part of the morning has been occupied with an executive session as our friends from the press, radio, and television know. We had with us Dr. Hans Bethe, Professor of Physics, Cornell University, and a member of Dr. Killian's committee on inspection of nuclear test suspension that has advised the President on this subject. Dr. Bethe's testimony will be released after review for the purpose of deletion of material which might be of a security nature.

Dr. Bethe reviewed with us the very difficult problems of detection and inspection of nuclear weapons tests and gave us the benefit of his scientific knowledge. I would say that it was one of the most fruitful, helpful, and informative sessions that the committee has had.

The session yesterday was also of a very high standard. I think we are beginning to gain information that is helpful to this subcommittee and will be helpful to the public.

INTRODUCTION OF ADMIRAL STRAUSS

The subcommittee's next witness is the Chairman of the Atomic Energy Commission, Admiral Lewis L. Strauss.

Admiral Strauss has been closely associated for many years with various phases of our defense program, having filled many responsible positions. In recognition of his service, he has been the recipient of such honors as the Navy Gold Star and the Army Oak Leaf Cluster.

Admiral Strauss was first appointed as a member of the Atomic Energy Commission in 1946. In 1953 he was named Special Assistant to the President on Atomic Matters, and that same year was appointed Chairman of the Atomic Energy Commission.

It is a privilege to have Admiral Strauss with us this morning. I am sure that his wealth of knowledge and experience will be helpful

to this subcommittee in its search for information and guidance which will help to brighten the path to peace.

I should like to add that if there are questions addressed to Admiral Strauss which he can answer frankly only in executive session, the subcommittee will go into closed session following the conclusion of this public hearing. Mindful of the importance of an informed public, especially to a system of Government such as ours, I am sure, Admiral Strauss, that you will be as frank and candid as you think possible in your public testimony.

Admiral, you have been most patient and considerate this morning. I want you to know that we are very grateful for your willingness to stay with us and to make your presentation. We are appreciative of your willingness to appear in public session. Please proceed as you wish. Since you have a prepared statement, we will try not to interrupt you unless necessary until you have finished reading it.

STATEMENT OF LEWIS L. STRAUSS, CHAIRMAN, UNITED STATES ATOMIC ENERGY COMMISSION

Mr. STRAUSS. Mr. Chairman, I am happy to be here today in response to your invitation to testify, and I would like to say also that it required no exercise of patience. This morning it was a privilege to be able to attend part of your executive session and to hear your distinguished witness, Dr. Bethe.

On the 31st of May last, you asked that I express my opinion on certain matters of interest to your committee and to do so on an unclassified basis if possible. I replied to these questions by letter in the light of the then current situation and offered to testify before your committee if and when you so desired. I would like at this point to also say that I would appreciate the opportunity of some testimony in executive session, particularly bearing on some of the testimony this morning.

It is your intention, I understand, that to the extent possible the testimony before your subcommittee should be in open session. This seems to me very much in the public interest. I have therefore prepared a statement which does not contain data which is restricted by the Atomic Energy Act. I am, of course, available at your convenience to discuss classified matters in executive session. My statement is as follows:

NEED OF DEFENDERS FOR HIGHLY DEVELOPED WEAPONS

Both as a citizen and as a Government official, I am aware that scientific advances in weaponry have increased, and are increasing, the ability of an aggressor nation to launch an attack which could be extremely damaging to the United States. Because we are a democracy, we are cast in the role of defenders and cede to totalitarian governments the role of aggressors. There is an enormous distinction in this statement of simple fact. The targets of the attacker are large, that is, our cities. The targets of the defenders are small, that is, enemy planes and missiles. Our weapons of the defender therefore need to be much more sophisticated in design than those of the aggressor. They must be both more accurate and more numerous than the weapons of the aggressor and, since many would be used over our

own or friendly territory, they must be designed to perform their function and to produce the absolute minimum of radioactive debris.

We do not desire to turn back the clock on scientific developments already achieved and, practically, we cannot. Nor can further Soviet scientific progress be arrested. Consequently, it must be the hope of all thoughtful men that a reliable and effective system can be negotiated for controlling the world's armament—a system which can reduce and finally eliminate the possibility of a third world war. For such a war unless it can be prevented will produce casualties in numbers that have been variously estimated, but there is no disagreement that they will be tragically great.

REQUIREMENTS OF DISARMAMENT AGREEMENT

I am convinced that any disarmament agreement, if it is to have a chance of reducing the possibility of disastrous war, must apply equitably to its parties. It must not be such as to impair the defensive and retaliatory power of ourselves and our allies without a convincingly compensating restriction on an aggressor's ability to attack.

To succeed, it must be a plan developed with an honest intent to avoid possible future aggression. History furnishes too many examples of disarmament attempts in the past which have been honored by one power and not the other and so have resulted in an imbalance of international power. Thus, situations have been produced where the violator has made his attack when he believed the time right and the other side sufficiently weakened and unprepared.

RECORD OF SOVIET UNION

All of us would like to have evidence that the Soviets desire to go forward rapidly and in parallel. Other than words, I am aware of no such evidence. In fact, the solid evidence that is available points the other way—to agreements violated for Soviet advantage. The course of history from the end of World War II to the present moment affords a long record of false propaganda and the use of force to achieve unjust ends. For example, we were accused of using germ warfare in Korea. Indeed, I am told that in many parts of the world, this perversion of the truth still remains anchored in the minds of people. But this is only one example of continuous past propaganda to which has been added the latest Russian announcement concerning a cessation of testing. This would apparently be without guarantees and it followed an extraordinarily elaborate series of tests and embodied a proviso that they could resume tests at their discretion.

We need only remember the subjugation of eastern European nations, of North Korea, and of Hungary to make us look at our future course with great circumspection. Soviet unwillingness to meet with the disarmament subcommittee of the United Nations ought to cast some doubt in our minds upon the sincerity of their expressed desire to reach a disarmament agreement. But the peoples of democracies have short memories because we are the victims of our own wishful thinking. We want to live in a peaceful world and we like to assume that this is the goal of everyone else as well.

This, then, leaves the United States and the free world in a difficult position. We intend to make every effort to achieve progress

along the road to disarmament. In the interest of humanity, we regularly participate in negotiations which may lead to such a development. We realize however, that the initial steps along that road must not be such, that if the agreement is violated, we would find ourselves in a vulnerable position, for then the possibility of war would be enhanced and the threat more disastrous.

NUCLEAR DISARMAMENT

With this as a background, I would now pass to certain specific aspects of nuclear disarmament, commenting more fully on these. In these further comments, I would like to explain:

(a) Why, under current conditions, the United States continues nuclear tests.

(b) Why we have contended that to stop the use in weapons of further production of fissionable materials (and the initiation of a program to reduce the existing nuclear weapon stockpiles) ought to be a part of the first step of any disarmament plan.

(c) Whether, in fact, a monitoring system can be developed to insure that unauthorized nuclear tests are not conducted without convincing detection (including identification).

(d) Whether a satisfactory monitoring system can be developed to insure that there is no violation of an agreement against the use of new production for weapons purposes.

WHY UNITED STATES CONTINUES WEAPONS TESTS

Let us take first the matter of why, under current conditions, the United States continues to test.

(a) The essentiality of nuclear weapons in the defense structure of the United States and its allies is established. Many of our friends live along the periphery of a land mass dominated by possible aggressors. The military forces of the free world, spread over long exterior lines, cannot defend themselves without the aid of nuclear weapons against a possible Communist aggressor who can move rapidly and concentrate at any point on the periphery. Turning from possible local aggression to defense of the United States itself against surprise attack, nuclear weapons constitute, I believe, the principal defensive military asset of our arsenal.

Yet, we are now, as you know, in a transition period insofar as nuclear weapon design is concerned. No longer are weapons systems such that nuclear warheads can be delivered only by large aircraft which require substantial time to launch and substantial time to reach their objective. Instead, systems are technically possible which permit very rapid delivery of weapons of various sizes and yields and on a major scale. The Soviets have demonstrated that they have, or can have in the future, an ability to deliver a very heavy attack. Our position is to be sure that such an aggression would be deterred by the assurance of retaliation or blunted if it eventuated.

Therefore, in defense of ourselves and our allies, we cannot place our dependence upon obsolete and obsolescent weapons systems or upon nuclear warheads of earlier design. New systems, to be truly effective, must be light, rugged, and instantly ready. If all types of aggression are to be avoided or countered, the systems and their war-

heads must be capable of use in all locales and in all environments.

We have made substantial strides in developing the weapons systems we need. Yet with regard to some, particularly those of extremely severe design characteristics, we still need further development and test. This is particularly true with regard to weapons of greatly reduced radioactive fallout. In the interest of civil populations, we are convinced that such weapons are a necessity in all types for both strategic and tactical use. We know now how to make certain of the designs we need, but by no means all. As I have indicated, it will require more development and more tests before we will have this comprehensive arsenal.

The interruption of testing will directly affect our development for there is no substitute for tests in determining whether a conventional weapon or a nuclear weapon will or will not perform as anticipated.

TEST CESSATION SHOULD BE PART OF MORE COMPREHENSIVE AGREEMENT

Here, may I underline one point in regard to cessation of testing. A cessation or moratorium on testing will not in itself be a step toward reducing existing armaments. On the contrary, in our case, it is a step which will interrupt the development of defensive systems, which we know can be developed in time and which we need. It is a very fateful step, therefore, and one which I have believed should only be taken in conjunction with other and more significant disarmament arrangements. I have felt that it is a step to be taken only when we can have assurance acceptable to prudent men, that the Soviet will not violate the agreement. It is a step to be taken, therefore, only if both parties are willing to allow the inspection necessary to reduce to the utmost the possibility of clandestine violation. And I repeat that it is a step which when taken will freeze our defensive research.

NECESSITY OF PRODUCTION CUTOFF AS PART OF FIRST STEP

I would like to turn now to the second of the specific matters—why we have contended to date that any first-step disarmament proposal should include a cutoff of the use of further production of fissionable material in weapons, and the initiation of an orderly, gradual transfer of earlier-produced fissionable materials to peaceful purposes.

(a) I believe the answer to this question follows naturally from my earlier comment relative to a test cessation or moratorium. As I have stated on other occasions, a test cessation as such, does nothing to reduce the existing weapon stockpiles. Furthermore, and importantly, it does nothing to curtail the improvement of an aggressor's delivery system. A future aggressor can go right ahead perfecting the missile on which the warhead rides and the reliability of guidance of this device.

(b) On the other hand, a new positive step in disarmament would be initiated by the cessation of the buildup of the weapons stockpiles. If coupled with the initiation of the return to other uses of already stockpiled fissionable material, it would be the beginning—though only the beginning—of a restriction on nuclear armaments. It would be a recognition by both the Soviets and ourselves that we were will-

ing to reverse the trend of building ever larger nuclear weapons stockpiles. It could be a real and substantial first step to disarmament.

MONITORING SYSTEM NECESSARY FOR TEST SUSPENSION

As for the third matter, I would like to comment briefly on whether a monitoring system could be developed to insure that unauthorized tests, if conducted, were detected, identified, and proven as nuclear tests of a specific nation. I understand that you have had executive testimony in this regard. Perhaps I can make a few remarks in this open session which may be helpful to wider public understanding of this difficult and most important problem.

(a) I believe that with regard to tests conducted on, above, or under the surface in the territory of a specific nation, a properly designed monitoring system can detect those of larger yield. The monitoring system required, however, if that yield of detectability is to extend down to smaller shots, will be complex. In any land mass such as the United States or Soviet Russia, it would require a large number of stations, sited and operated as the observers deem necessary. More importantly, too, if suspected detonations are to be identified as nuclear detonations and proven as such, the right of immediate access to any suspected area must be allowed. Even then, there will be no assurance that all nuclear detonations can be identified as such. It is my understanding that even with a very elaborate inspection system including the right to visit suspected underground explosion sites, there still remains a real possibility that sucessful clandestine tests sufficiently large in yield to contribute materially to a weapons development program could be carried out by a determined violator.

(b) Then, too, if a nation tested in an area where a proper detection net was not installed, the proving of the violation would be most difficult if not impossible.

INSPECTION OF PRODUCTION CUTOFF

As a final matter, I would like to comment on the problem of establishing a satisfactory system of safeguards for monitoring an agreement to devote all future production of fissionable materials to peaceful uses.

(a) I know you have received detailed comments in this regard from Dr. Spofford G. English of the Atomic Energy Commission staff. He has pointed out in his testimony that a system of accountability and physical security for inspection and control of materials, if made in a known large production facility will require, for example, an inspection force approximately 500 men for the case of a plutonium production plant consisting of a number of large reactors and their associated fuel fabrication and chemical processing facilities. The manpower required will vary somewhat depending on the size and character of each specific installation. It is believed, however, that such a system will give a high degree of assurance of suspecting diversions of as little as 1 percent of the plant's throughput over a period of a year. This would not be so accurate a system for periods of shorter duration.

The total force required for inspecting a country would depend on the total number and kind of facilities to be inspected and would have

to include teams for inspecting to assure that no clandestine plants were in operation. It must be borne in mind that no system we can think of will guarantee 100-percent assurance against diversion.

(b) Here, as in a test moratorium, any inspection systems, if to have any chance of being effective, must permit the monitors to visit freely and rapidly any area they suspect. It must permit the monitors entry into, understanding of, and continual observance where necessary of the plants of their operation. Without such access, clandestine and undetected operation of production plans could go forward.

(c) In summary, then, I believe a monitoring system capable of achieving a reasonable degree of success is a possibility. It would require a major outlay of means but I regard that as of little consequence where the stakes are so great. It would require that both parties permit full access to all plants and personnel concerned, and rapid and immediate access to areas wherever the party could engage in the production of material.

It is my understanding that you desired the opening testimony to be as brief as possible in the interest of allowing time for questioning and discussion. I have therefore directed this statement to the relationship of nuclear restrictions to an overall disarmament plan and I have indicated certain strongly held ideas of my own. I am available and will continue to be available to questions in open or closed session in further elaboration of any points of concern to you, or members of the committee. Thank you for permitting me to present the statement.

UNITED STATES POLICY ON NUCLEAR DISARMAMENT

Senator HUMPHREY. Thank you very much, Mr. Chairman. The discussions today will, I hope, center around what is the declared national policy. As I understand it, the President, with the advice and counsel of the National Security Council and other officials, approved a set of proposals on nuclear weapons control. These included (1) the suspension of nuclear weapons tests for a 2-year period with an inspection system to verify this suspension, (2) a cutoff of production of fissionable materials for weapons purposes along with an inspection system to verify the cutoff, (3) the prohibition of the transfer of nuclear weapons to other countries (no inspection was provided for this proposal), (4) the transfer of some fissionable materials from weapons stockpiles to peaceful uses under international supervision. I believe that is an accurate summation of what is the current policy not only of our own Government but, in addition, it has the approval of our NATO allies.

Mr. STRAUSS. I can confirm that, Senator. I believe that there is some difference in the wording, but that is my general understanding.

Senator HUMPHREY. I think, without going into precise terminology, that this is a fair summation. So we are discussing primarily the reliability of an inspection and detection system, because it is clearly understood that the President of the United States and the Secretary of State, who is his agent, can and could negotiate an agreement with any other country relating to these matters.

Of course, that agreement, if in the form of a treaty, would have to come back here to the United States Senate for ratification. Therefore the members of this subcommittee are attempting to ac-

quaint themselves with the possibilities under such an agreement and to prepare ourselves better for that responsibility.

Regardless of whether we trust the Soviets or don't trust the Soviets, and I know that we are not approving their system even though we may negotiate with them, what we are attempting to do is to find out whether or not these proposals can really protect the national security of the United States with an inspection system. We get down to that.

I don't think it is necessary to argue whether or not the President is right or wrong about this. That can be argued. But the important point is that he is in charge.

He is the President and he is at liberty as our President to be in consultation with other nations and seek agreements, either executive agreements or treaties. Now we come to the question of inspection and detection.

Mr. STRAUSS. I would only say, Senator, that I think this is a very constructive and helpful procedure from my point of view.

FEASIBILITY OF TEST SUSPENISON WITHOUT PRODUCTION CUTOFF

Senator HUMPHREY. Thank you, sir. There has been an argument, or at least I would hope a constructive discussion, as to whether or not the package of the suspension of nuclear weapons tests with inspection and the cutoff on the production of nuclear materials for weapons purposes with inspection could be separated without jeopardizing our security. What would be your point of view on that?

Mr. STRAUSS. I would like to emphasize here, Senator Humphrey, that I am testifying as to my personal point of view.

Senator HUMPHREY. Yes, sir.

Mr. STRAUSS. My belief is that the emphasis on the cessation of testing is a great mistake, or rather a very spurious argument from the point of view of its effect on disarmament or the security of the world.

The real danger to the human race is not the continuance of weapons tests. The real danger to the human race is a nuclear war.

Our weapons tests to perfect our stockpile of nuclear weapons has as its purpose the deterrence of a nuclear war. Over the period of centuries the developments of new weapons have preceded by a considerable number of years the development of countermeasures to those weapons. The weapons have, when they first appeared, seemed to be invincible. I won't burden you with citations from history with which you are undoubtedly more familiar than I am, the use of the long bow at Crecy against armed knights is a case in point.

The development of the atomic weapon was assumed and announced and believed to be the ultimate weapon, with no defense against it. We are now in the period of developing defenses.

Since we are defendant Nation and cast in that role by the fact that we are a democracy and are not aggressors, it would be a tragic mistake in my opinion to cease the development of our defenses unless the whole threat of a surprise attack with atomic weapons were cancelled at the same time.

Now this is a personal point of view. I hold it very strongly, about as strongly as any opinion that I have.

Senator HUMPHREY. I am sure we respect your personal point of view, Admiral, and it has been very well stated.

Mr. STRAUSS. Thank you.

ADEQUACY OF NUCLEAR STOCKPILE

Senator HUMPHREY. Do you believe that our present atomic-thermonuclear weapons stockpile is superior to that of the Soviet Union in quantity, in quality, design and variety?

Mr. STRAUSS. The answer to that question, Mr. Chairman, is based to a very considerable extent upon the interpretations from intelligence data.

It is my belief, which I cannot substantiate, but having been in the business of manufacturing weapons for a period of some years, longer than the Soviets, that we have more weapons. It is my belief that we have more efficient weapons.

But it would be a great mistake to assume that if those two points that I have made are accurate and true, that the weapons which they have, which we know they have, would not be sufficient with the proper delivery systems available to mount a very devastating attack.

Senator HUMPHREY. But it would be presumed, would it not, Admiral, that if such a devastating attack were mounted as an aggressive act, our stockpile would not be locked up but we would retaliate?

Mr. STRAUSS. That is the announced policy of the Government.

Senator HUMPHREY. Therefore the deterrent effect upon which we have relied, at least in part, as a means of maintaining the peace, would still exist regardless of the cessation of tests, is that not true?

Mr. STRAUSS. That is true, but there are instances in history, and some in recent history, where the existence of an overwhelming force has not prevented military adventures that have been disastrous to the aggressors, and which in the light of history will seem to have been very imprudent and unreasonable adventures on the part of the aggressors.

We must be prepared to protect our people from the consequences of so ill-advised attack by an aggressor, if we can, by destroying his weapons before they impact on our cities.

RELATION OF TEST SUSPENSION TO GENERAL DISARMAMENT

Senator HUMPHREY. I believe the point that you have made, Admiral, is related to the cessation of tests as a part of the disarmament picture, and its contribution to peace is well taken.

I want my own position well understood.

I have never felt that merely getting an agreement, if you could get one, on the cessation of tests would necessarily mean disarmament. It does not mean that. It means that you have a very slight beginning in obtaining an agreement with a power with which it has been difficult to date to deal and with which to have agreements.

Mr. STRAUSS. I am glad to hear you say it, Senator, because I think your position has in some quarters been misrepresented.

Senator HUMPHREY. My position is quite well known. I think peace will be obtained when nations learn how to live together; when the great political settlements are made; and when we are able to

remove the causes of the tensions, and weapons are in my mind a manifestation of tensions, and of course sometimes contribute to them.

Nevertheless, as I have indicated a number of times, I have felt that if you could get an agreement on inspection which would provide, as you have indicated here, mobility, access, the stations and the facilities within the Soviet Union and behind the Iron Curtain, that this inspection agreement within itself, would be a very significant political development that might very well contribute to the peace that one seeks, because peace is impossible without developing confidence.

What is your view about that, Admiral? I gave you my point of view.

Mr. STRAUSS. I think I concur with most of what you have said. I believe that the one point which has been omitted from our joint consideration up to this point is the fact that even if such a development came to pass, and if both sides in good faith ceased to develop their weapons beyond their present state, they would both go ahead to produce to add to their stockpile existing numbers and the aggressor could continue to perfect his, what shall I say, delivery system, his missile and its guidance.

This, I believe, is one of the principal reasons why a freeze of the defensive posture would work to our consistent disadvantage.

Senator HUMPHREY. I might just add most respectfully that there has been nothing that has impeded us to develop our delivery systems up to date except lack of will. We haven't been under any wraps at all. We seem to be a little bit behind in delivery systems so far.

Now that is not your responsibility, but from everything I have read and from what I have heard, the delivery system rate has not been impeded by any kind of legalistic barrier in our own country. It has been impeded by apparently underestimating the requirements of the day and the strength of the opposition.

But your point is that a defensive weapon has to be more sophisticated, and therefore the cessation of testing might impede the development of such.

Mr. STRAUSS. That is right, Senator.

Senator HUMPHREY. Your point is also that we have a superiority at the moment.

Mr. STRAUSS. It is my belief, but that is a matter of opinion and not verifiable.

Senator HUMPHREY. I want to just call your attention to one or two statements and then I wish to turn this over to my colleagues.

INSPECTION OF PRODUCTION CUTOFF

You pointed out whether a satisfactory monitoring system can be developed to insure that there is no violation of agreement against the use of new production for weapons purposes was one of the objectives that you have in mind. Do you think such a monitoring system can be developed?

Mr. STRAUSS. Yes, senator; I do. I think it will be difficult and expensive. I discounted the expense early in the consideration because you can't put a price on such an achievement.

INSPECTION OF TEST SUSPENSION

Senator HUMPHREY. Do you believe that a satisfactory monitoring and inspection system can be developed to safeguard our national security in case we entered into an agreement on the stopping of nuclear tests for weapons?

Mr. STRAUSS. Alone?

Senator HUMPHREY. Yes.

Mr. STRAUSS. No, Senator. My belief is that a cessation of testing alone will result in an improvement of the aggressor's system and a freezing of the defender's system.

I do not deny that there can be considerations other than those that I have taken into consideration, political and otherwise, which may persuade men of judgment that it is the thing to do. I believe that I will continue to view it as unwise.

Senator HUMPHREY. The question was: Do you think that we could develop a monitoring inspection and detection system that would safeguard our interests in terms of violations in case of an agreement on the cessation of tests?

Mr. STRAUSS. No. Senator, I think a system can be devised which would detect all except quite small weapons. I believe that it would be possible to continue development with quite small weapons.

I believe it will be possible for a determined violator to conduct tests in some quarter where there is no inspection net, and then it would be impossible, even when they were detected to identify the violator. Let me cite an instance.

Suppose a submarine were to test an atomic weapon, let's say, off Cape Canaveral or off Eniwetok. I don't know how anyone could convince beyond a doubt the people of the world that that weapon had been tested by country X or Y or Z. This bothers me.

Senator HUMPHREY. I understand. You heard some of the testimony this morning which is still classified. I gather there was some difference as to point of view, is that correct?

Mr. STRAUSS. Yes. The differences were not on technical questions.

Senator HUMPHREY. No, they were on judgment.

Mr. STRAUSS. I agree with Dr. Bethe and respect his judgment on all technical matters and we continually employ him, avail ourselves of his knowledge and his services as chairman of one of our important committees.

Senator HUMPHREY. This is my final question, and then I am going to turn it over to my colleagues. As I understand it, while you believe that an effective monitoring system can be devised for a cutoff of materials, you do not believe that an effective monitoring system could be devised for the cessation of tests alone that would prevent violation and evasion, particularly in the small weapons class, is that right?

Mr. STRAUSS. I think, Senator, I would agree with that. I have been careful to express it in terms in which I had weighed words in my statement, but I would accept your paraphrase. Let me restate it. I believe that a determined violator could continue a program of testing quite small weapons without sure detection.

RELATIVE EFFECT OF TEST SUSPENSION

Senator HUMPHREY. Do you believe that a cessation of tests would be more advantageous to the United States or to the Union of Soviet Socialist Republics?

Mr. STRAUSS. At the moment I believe it would be more advantageous to the Russians.

Senator HUMPHREY. Do you believe that it would retard our technological progress in variety of weapons for defensive purposes?

Mr. STRAUSS. I think it would end it.

POSITION ON UNITED STATES PROPOSALS

Senator HUMPHREY. It would end it. Therefore in light of this testimony, Admiral, do you support the President's proposal that we negotiate a test suspension and a cutoff of nuclear materials production with inspection?

Mr. STRAUSS. I certainly do, Senator.

Senator HUMPHREY. Despite what you have said, despite the fact that you believe that it would retard our technology in defensive weapons, that it would be advantageous to the Soviet Union?

The President has indicated, as I have said, not only indicated but has stated that we are prepared at any time to negotiate with the Soviet Union an international agreement for the cutoff of the production of nuclear materials along with the cessation of tests.

Mr. STRAUSS. No, I don't think he said for the suspension of the production of nuclear materials.

Senator HUMPHREY. For weapons purposes.

Mr. STRAUSS. That is right.

Senator HUMPHREY. And for the suspension of atomic weapons tests.

Mr. STRAUSS. That is right.

Senator HUMPHREY. With international inspection.

Mr. STRAUSS. That is right, and that is the reason I said a short while ago that there were considerations, political and other considerations, which would be overriding.

That is to say if tests can be suspended and the production of fissionable material for weapons can be suspended for an equivalent period, and the gradual and orderly reduction of weapons stockpiles, existing weapons stockpiles can be arranged as a part of this general arrangement, all inspected by the most liberal arrangement of access, then I would be for it. I have said so.

Senator HUMPHREY. But your testimony states quite categorically that we would pay a very severe price for that.

Mr. STRAUSS. We pay a price, that is right.

Senator HUMPHREY. A very severe price. Of course I want to say I have never been able to understand why we would want to liquidate our stockpiles if we were uncertain as to the efficacy or the reliability of the inspection and the possibility of cheating. We apparently have a larger stockpile, do we not?

Mr. STRAUSS. I think we have a larger stockpile.

Senator HUMPHREY. Then why do we want to liquidate the stockpile if we are not sure that the other fellow is also doing so?

Mr. STRAUSS. It would not be unilateral.

Senator HUMPHREY. No, but we would ask them to reduce their stockpile and we would reduce ours. But if they could cheat on inspection—we were told yesterday by Dr. Teller that it was impossible, I think that was the word, to be able to inspect the stockpile.

Mr. STRAUSS. I think it is generally recognized that a stockpile in being can be hidden. But if such an agreement provided that country A would produce X quantity of weapons when country B produced X quantity of weapons and they were mutually destroyed under proper inspection, it would make no difference where they had been hidden meanwhile. They would have to come out of hiding for that purpose.

Senator HUMPHREY. But we still wouldn't know what the amount of the stockpile was.

Mr. STRAUSS. No, you would not know, and you would in prudence not divest yourself of everything you had until you were in some way satisfied that you had not been put at a disadvantage.

BREAKING UP THE DISARMAMENT PACKAGE

Senator HUMPHREY. What disturbs me is that you are willing to support the total package but there are within the total package at least one or two items that you feel are very undesirable. I wonder why we don't try to find just one item on which we can agree might be to our interest to gain acceptance.

Mr. STRAUSS. I think that is the least desirable from our point of view. I think the cessation of the development of our defense system would be the most important concession we would make, and to make it the first concession before anything else were done would be a piece of very poor trading, from my point of view.

Senator HUMPHREY. We have heard testimony to the effect that had we been able to get a cutoff on weapons testing let's say a few years ago, we would have been at a very advantageous position.

Mr. STRAUSS. I take great exception to the validity of that testimony. It was proposed that we should stop testing and even that we should not make a thermonuclear weapon. Had we done so, we would have been——

Senator HUMPHREY. I am not speaking of that instance.

Mr. STRAUSS. This was another instance. We would have been confronted by a situation in which the Soviets had thermonuclear weapons, and we would not have even begun research on them.

Senator HUMPHREY. I would say that that would bear some further examination in executive session, because at the time I doubt that one could call it a weapon. Wouldn't that be more accurate?

Mr. STRAUSS. I would like to talk about it in executive session.

Senator HUMPHREY. Yes, I think so. I yield to Senator Byrd.

Senator BYRD. Our very distinguished chairman has asked some questions that I have had in mind, and so I do not have any questions. I do want to say, however, that I think Admiral Strauss has made a very clear and fine presentation on this most important and difficult question, and I want to congratulate you on it.

Senator HUMPHREY. Senator Hickenlooper?

Senator HICKENLOOPER. Yes, Mr. Chairman.

When did you propose to recess?

Senator HUMPHREY. I think we will continue a few more minutes. I thought we would try to get a run down of the Senators who are here who can come back this afternoon. Can you afford the time, Admiral?

Mr. STRAUSS. I am completely at your disposal.

Senator HUMPHREY. You are very kind.

Senator HICKENLOOPER. Mr. Chairman, I want to say that I think you have made a very concise and helpful statement here of the attitude and views which you hold on a phase of this subject which is very important.

I am especially impressed with the clarity with which you have pointed out the fact that if we stop testing weapons and defensive systems—those are not your words, but I am interpolating—we are playing right into Soviet hands, because our defensive progress will have stopped and the Soviet Union could go right ahead increasing stockpiles and increasing delivery systems.

INCLUSION OF COMMUNIST CHINA

We have heard a lot about making agreements with the Soviet Union on stopping testing or decreasing stockpiles or other measures. What about China? Suppose we made an agreement with the Russians that tests would stop. Suppose tests started next year in China some place. We might assume that the Soviets were directing the tests, but still they would be in China and China would be no party to this agreement. What would we do in that case?

Mr. STRAUSS. I think an effective monitoring system would have to include all areas available to the presumed testing nation.

Senator HICKENLOOPER. I presume at least in theory under the idea of sovereignty that China would say that Russia has no accessibility to China, that the Red Chinese were doing the testing.

That is in theory. It poses a problem where there is an area in the world which, under the agreement with Russia we would have no access to. We could say nothing about it except to explain, if these tests occurred in China.

Mr. STRAUSS. This is certainly one of the questions that would have to be resolved, Senator.

Senator HICKENLOOPER. Do you believe that an agreement with Russia alone would at all answer that problem, even though the Soviet Union said they would use their good offices to attempt to discourage tests in other parts of the world?

Mr. STRAUSS. I don't think I would so regard it.

PROCEDURE IN EVENT OF TEST SUSPENSION VIOLATION

Senator HICKENLOOPER. Suppose we made an agreement to suspend tests with some nation that had large quantities of atomic weapons, and suppose that nation violated the agreement, and in violating it they said, "What are you going to do about it?"

That immediately raises the question of what would we do about it if they continued their tests. We would keep our word, but what would be the punishment for violations?

Mr. STRAUSS. The only thing that has occurred to me under those circumstances is that we would resume our testing, but that does pose this difficulty, Senator Hickenlooper.

Our laboratories would suffer. One does not know to what extent they would suffer during a period of test suspension. The Russian laboratories conceivably would remain intact, that is to say the people who worked in those laboratories worked by direction and they would be restrained to those laboratories. They certainly could not leave of their own volition, as we understand things to obtain in Russia.

Our good men might feel that they would still like to work on defense projects, but there would be other projects active, and our weapons project would be suspended, and I think the laboratories would be likely to lose many good men whom we could not afford to spare, and therefore there would be a lapse of time after we wished to resume testing before the full speed could be resumed. Perhaps a year or two would be lost.

WORLDWIDE AGREEMENT ON TEST SUSPENSION

Senator HICKENLOOPER. While we are talking about the possibilities involved in this matter, I would like to ask another question. You have mentioned a moment ago something about a test, for instance, in the Pacific Ocean some place by an unidentified power. I mentioned to you just a moment ago the possibility of tests going on on the continent, the mainland of China, ostensibly under the auspices of the Red Chinese. I could envision some other places in the world where possibly tests might go on, some of the so-called independent satellite countries, which would at least in theory not be in violation of an agreement which the Russians and the United States might enter.

Would you think that any kind of an agreement of that kind should reasonably include all of the countries of the world?

Mr. STRAUSS. To be ideal it certainly should. I don't necessarily feel that it should be a consideration with respect to countries which we had good reason to know at the outset had no weapons capability of their own. That is to say—I like to avoid naming names, but let us say—a satellite country that had definitely no weapons capability, and that there was a detonation within its territory. One might very reasonably assume that the weapon had been supplied and that it was of Soviet manufacture.

Senator HICKENLOOPER. I presume one could assume it, but what of the complications that would rise from an international standpoint?

Mr. STRAUSS. That is why I made a point of identification as being an important consideration, Senator, not only detection but identification.

Senator HICKENLOOPER. It is entirely conceivable and I think it would be within the conspiratorial possibility that Red China could say, "We have no particularly atomic capabilities at this moment," but next year they might in some way in some manner secure hundreds of capable scientists, and we might not be able to tell where the scientists came from. They might be able to build plants or they might be able to explode weapons.

We could assume all we wanted to that the Soviets had done the job, but the proof might be very, very difficult as to the violation.

Now perhaps some of these things are farfetched, but I don't belive that they are beyond the bounds of a determined conspiratorial effort. I think they might be very practical devices used in a conspiratorial manner to avoid or to circumvent these agreements, if that was the desire of certain aggressor nations.

METHODS OF INCREASING SECURITY

As I understand it it is your theory, personal theory, that as we perfect and make more reliable means of combating weapons attack, that we make aggression less attractive to the fellow who might want to become an aggressor.

Mr. STRAUSS. That is my belief, Senator.

Senator HICKENLOOPER. And that therein lies a greater hope for peace than if we froze our testing program at this time, and let the production of atomic weapons go on and the stockpiling go on. We would then indeed be getting into a time of greater danger as time went on, is that correct?

Mr. STRAUSS. That is correct. That is my belief.

Senator HUMPHREY. We could recess now. I understand that the Admiral can come back here at 2:30. Will that be agreeable with all of you?

Mr. STRAUSS. Anything you say.

Senator HUMPHREY. We will be back in open session in the same room at 2:30. May I add that we are also going to have Dr. Teller back for some additional testimony this afternoon.

(Thereupon, at 1:10 p. m., the subcommittee took a recess until 2:30 p. m. of the same day.)

AFTERNOON SESSION

Senator HUMPHREY. The subcommittee will reconvene. I believe when we recessed Senator Symington was about to start questioning. Senator Symington, do you want to proceed with whatever questions you may have?

Senator SYMINGTON. Thank you, Mr. Chairman.

Admiral, it is always a pleasure to see you, sir.

STATEMENT OF LEWIS L. STRAUSS, CHAIRMAN, ATOMIC ENERGY COMMISSION—Resumed

Mr. STRAUSS. Thank you, Senator.

Senator SYMINGTON. I have three or four points here. I may have some questions later, with the Chair's approval.

What worries me about this situation is all the information and denials and assertions that are going around on a subject which is so important to the future security of the country.

ADVERTISEMENT CONCERNING NUCLEAR TESTS

I would ask you a question about an advertisement. Have you seen this advertisement in the New York Times the other day, a full-page advertisement?

NUCLEAR BOMBS CAN

NUCLEAR TESTS ARE ENDAN

CAN DESTROY ALL LIFE IN WAR

NDANGERING OUR HEALTH RIGHT NOW

NUCLEAR TESTS ARE ENDANGERI

WE MUST POSTPONE OUR COMING TE

1. The Soviet Union states it is calling off further nuclear tests. The easiest way for us to convert this announcement into a moral disaster for the United States is to stand pat on this issue. The least we can do today—if we hope to restore America's moral standing in the world—is to postpone our tests. Presidoent Eisenhower's April 7 letter to Khrushchev regains some of the ground lost by our first response to the Soviet announcement. The President's recommendation for technical studies preliminary to a broad disarmament agreement deserves the widest possible support. But much more has to be done!

2. It is true that the Soviet Union waited until it completed its Spring tests which sharply increased poisonous radioactive strontium in the atmosphere. But it makes no sense for the United States to complain about radioactivity from the Russian tests and then plan to add to it with our own tests. Estimated nuclear box score to date: United States100-odd tests; Soviet Union—50-odd tests.

3. The U. S. Atomic Energy Commission now admits that radioactive fallout is a matter for genuine concern and that the United States is the hottest radioactive place in the world. Scientists warn that thousands of babies will be born malformed because of tests to date. Many thousands more people will prematurely die of diseases of blood and bone.

WE MUST CALL FOR A UNITED NATIONS INSPECTED BAN ON TESTS

1. We must challenge Moscow's bid by proposing a permanent end to tests under effective inspection. Khrushchev said on April 4: 'Russia is willing to accept supervision." Let's call his hand.

2. Dr. Libby of the Atomic En
that detection of nuclear expl
to the much publicized doubts
AEC has said that last year's
was detected only 250 miles
that the test was detected in
A hydrogen bomb is many
powerful than the "tiny" bom
test.

3. Tests deemed necessary for pe
ducted by an international age
must be stopped.

WE MUST NOT SUPPLY BOMB MATE

Bills now before Congress would
materials, parts and weapons
countries.

This would mean more nuclear
"suicide club": Korea is pressing
powers are seeking them. Turkey
Then Pakistan. Moscow will
nuclear power. Fuses could be

We would increase the chance
launched by some minor military
anonymous French colonel who
Tunisian village, using America

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MARK STARR

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GERING OUR HEALTH RIGHT NOW

ING TESTS

he Atomic Energy Commission concedes f nuclear explosions is feasible, contrary olicized doubts of Dr. Edward Teller. The hat last year's underground test in Nevada nly 250 miles away. Now it is revealed as detected in Alaska, 2300 miles away. omb is many thousands of times more he "tiny" bomb used in the underground

ecessary for peaceful purposes can be con- ternational agency. Nuclear weapons tests d.

PLY BOMB MATERIALS TO OTHER COUNTRIES

Congress would authorize transfer of bomb nd weapons design blueprints to other

more nuclear powers and so extend the rea is pressing for nuclear arms. NATO them. Turkey will certainly want them. Moscow will make Communist China a ases could be set all over the world.

se the chance of accidental atomic war, minor military commander. Witness the h colonel who ordered the attack on a sing American-made planes.

AMERICAN SECURITY AND WORLD SECURITY ARE NOW ONE

America must give leadership for world disarmament and conditions that make for a just and workable peace. We must stop the contamination of the air, the milk children drink, the food we eat.

While there is yet time, let us come to life on this issue and take the moral initiative.

ACT NOW—FOR MAN'S SAKE

Write President Eisenhower, The White House, Washington, D. C., and Vice-President Nixon, The Capitol, Washington, D. C.

Write your U. S. Senator and Representative in Washington opposing the bills to transfer bomb materials to other countries and favoring an end to nuclear tests as a first step toward a broader disarmament. Send a copy to Senator John O. Pastore of the Joint Committee on Atomic Energy.

Write your newspaper editor, or news comentator.

Organize a group, or work with existing ones in your community.

Write the National Committee for permission to reprint this advertisement in your home paper. We'll tell you how to do it.

Send a contribution to this Committee to keep it going and expand its influence. Your moral support is heartening. Your financial support is *imperative*. Use the coupon below.

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(The signers of this statement do so as individuals and not as representatives of organizations or as members of the National Committee for a Sane Nuclear Policy. Asterisk indicates members of the National Executive Committee.)

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NYT

NUCLEAR BOMB

Mr. STRAUSS. I had heard about it, Senator, and I saw it this morning for the first time.

Senator SYMINGTON. Can I read you some of the things that it says very briefly. It says:

> It is true that the Soviet Union waited until it completed its spring tests which sharply increased poisonous radioactive strontium in the atmosphere. But it makes no sense for the United States to complain about radioactivity from Russian tests and then plan to add to it with our own tests.

I am picking at random in the advertisement.

Mr. STRAUSS. Should I comment on that, Senator?

Senator SYMINGTON. I want to ask you to, but I would like to read a little more. Mr. Chairman, may I ask that this advertisement be made a part of the record?

Senator HUMPHREY. Yes, the full text and its sponsors.

(The document referred to is on opposite page.)

Senator SYMINGTON. Then it says:

> The United States Atomic Energy Commission now admits that radioactive fallout is a matter for genuine concern and that the United States is the hottest radioactive place in the world. Scientists warn that thousands of babies will be born malformed because of tests to date. Many thousands more people will prematurely die of diseases of blood and bone.

The advertisement, of course, wants to stop tests now. It says:

> America must give leadership for world disarmament and conditions that make for a just and workable peace. We must stop the contamination of the air, the milk children drink, the food we eat.

I am going to send this advertisement down to you, if I may.

Mr. STRAUSS. Thank you, sir.

Senator SYMINGTON. What worries me is that among other things there appears to be an effort now to stop the testing of our weapons systems, and to the best of my knowledge—the chairman could correct me if I am wrong—nobody has suggested that we stop the current tests that are coming up shortly. I believe that is correct, is it not?

Senator HUMPHREY. I don't believe anyone in this committee has, and I haven't heard anybody who is an official of the Government.

Senator SYMINGTON. I don't remember that any witness before this committee has said we should stop the tests now.

Senator HUMPHREY. I don't think any witness has.

Senator SYMINGTON. On the other hand, this advertisement says we should stop them now. Some very fine people have signed it, and they base it on the premise that we are rapidly poisoning the earth, you might say, especially the United States, the way it reads.

Now all the testimony that we have gotten as to what is the condition today with respect to contamination of the atmosphere does not bear out this advertisement. Nevertheless in our form of government the people are supposed to be the final authority.

I am going to ask you some questions later on that. However, millions of Americans will get an impression from this advertisement which, unless the Atomic Energy Commission is misleading us, is not the right impression.

Admiral, I believe that is a presentation of the problem which you, sir, with your tremendous responsibility to the American people and your office realize, I am sure, is a very important one. I would appreciate your comment on it.

CAMPAIGN AGAINST TESTS

Mr. STRAUSS. Thank you, Senator, and thank you for showing me this advertisement about which I had heard and which I read quite hastily this morning and have since surveyed briefly.

I glance over the signatures attached to it, and I find among them the names of people who are my friends. I am sure that among these people there are many very good and intelligent and patriotic citizens. I note, and draw no inferences from it, because I don't think that one can safely draw any inferences, that this advertisement has appeared and this committee has been organized at the same time that a very high degree of organization for similar movements seems to have developed in England, in West Germany, and so on.

I also note that these organizations have become active at the outset of our tests and since the Russian tests, and have just noted it——

Senator SYMINGTON. I did not hear that. Would you repeat that?

Mr. STRAUSS. That these organizations so far as I have been able to deduce from the press, have appeared and begun their activity since the termination of the Russian test series, or what we believe is its termination, and the beginning of our test series.

Senator HUMPHREY. Would the Senator permit me to make a correction here. That committee to which you are referring began action before the termination of the Russian series, considerably before. I think that the record ought to be accurate on that.

Mr. STRAUSS. I am very interested to hear it, Senator.

Senator HUMPHREY. I believe that committee is called the National Committee for a Sane Nuclear Policy?

Mr. STRAUSS. I have never seen the advertisement before, and I just assumed that this publication on April 11 was the first publication. It may very well have appeared before.

Senator HUMPHREY. I know they have been conducting activities of this type for several months.

Senator SYMINGTON. Let's put it this way. It is the first time that an advertisement of this kind has in due course come before you, is it not?

Mr. STRAUSS. I think maybe a year or two ago I saw such an advertisement, but I don't recollect the name of the organization, and whether it was the same or not——

Senator SYMINGTON. In any case, this is the first time you as chairman of the Atomic Energy Commission have seen an advertisement of that type and character by this organization.

Mr. STRAUSS. As far as I can recollect. I would like to qualify it that way.

Senator SYMINGTON. Will you correct the record on that if it is wrong?

Mr. STRAUSS. I will gladly do that, sir.

RADIOACTIVITY FROM NUCLEAR TESTS

Two thoughts only occur to me as you read from it, Senator. One had to do with language—here it is:

"It makes no sense for the United States to complain about radioactivity from the Russian tests."

I can't identify any formal official complaint that we have made to that effect. If it has occurred——

Senator ANDERSON. Didn't Dr. Libby issue a statement to the effect that the Russian contamination was greater than ours?

Mr. STRAUSS. I did not, sir.

Senator ANDERSON. I said, "Dr. Libby."

Mr. STRAUSS. And I have been until now the spokesman on this subject. I have not issued any.

Senator ANDERSON. Then Dr. Libby is not to be regarded as a spokesman?

Mr. STRAUSS. No; I didn't say that, Senator. I said that I had not issued such a statement.

HEALTH EFFECTS OF RADIOACTIVE FALLOUT

Senator SYMINGTON. I would like to pursue that a minute there, if I may, Mr. Chairman. Even if Dr. Libby did say the Russians had done more than we did or we did more than they did, if the figures are remotely correct, in Dr. Teller's book, the amount of contamination from the standpoint of actual danger to the people today from worldwide fallout is not something that we should be alarmed about. Isn't that a fair statement?

Mr. STRAUSS. Yes; I think in the sense of alarm. We are concerned and have been concerned with the problem of fallout for years, and very properly we have been concerned about it.

Senator SYMINGTON. I agree with the concern, and I don't mean that it is not a very serious matter. But this book presumably is written by some people who know what they are talking about, and if they are wrong we would like to know that. On page 124 it shows the reduced life expectancy by various things you do, like smoking or living in the country instead of the city, and so forth, from 9 years to one roentgen of radiation, 5 to 10 days.

Then it says the worldwide fallout might be responsible for 1 to 2 days' reduction in life expectancy.

We tried to find out if that is true and have not been able to find out yet. I believe there was some testimony that 1 to 2 days might be changed to 2 to 3 days or something of that character by the latest tests.

On the other hand, if we want to stop testing because of reasons which are agreed upon between ourselves and any possible enemy, that is one thing; but, if we are going to stop testing because we are afraid that we are poisoning ourselves by testing, then the facts as I see them should be given out to the people as to whether that is correct or not.

REPORT OF NATIONAL ACADEMY OF SCIENCES

Mr. STRAUSS. So far as I know, Senator, the only authoritative facts on these subjects have come from the Commission. The National Academy of Sciences, at our request and financed privately, undertook a study in 1955 of the effect of radiation on human beings.

They published it, both a scientific and a popularized version, and came to the conclusion that if testing continued into the future at the rate it had taken place prior to that time that the amount of radiation to which human beings would be subjected over and above the amount

normally experienced from other causes, inescapable experience from cosmic radiation and the radioactive materials in the soil and in our own bodies, and voluntarily experienced in the medical profession, that the addition—and this word I quote from the report of the National Academy of Sciences—was negligible.

There was some spread as to what fraction of a roentgen was involved, out of a total of seven roentgens received from all other sources during the course of the normal reproductive lifetime of a human being.

I believe it has been definitely established that an individual voluntarily accepts more radiation from the normal luminous dial wristwatch than he has received from fallout. Therefore, the language in this advertisement to say that the Commission now admits—I will have to find it, I made that note as you read—et cetera, is misleading. It indicates that something has just occurred that causes us to be concerned about fallout.

Senator SYMINGTON. Is it true that a luminous dial wristwatch gives you more of a dose of roentgens than worldwide fallout, and when you get to a chest X-ray, you do really get a great deal more?

Mr. STRAUSS. Yes, sir; that is my understanding again.

Senator SYMINGTON. Then in general this is correct; is that right?

Mr. STRAUSS. I believe so, because in those instances where the author—I recognize the book from the jacket——

Senator SYMINGTON. By Dr. Teller and Dr. Latter.

Mr. STRAUSS. Speaking of matters outside of their particular disciplines, medical matters, that they had access to the best information available in the medicine and biology division of the Commission.

Senator SYMINGTON. Now if I may, referring back, you said something that to the best of your knowledge this type and character of advertising had come since the Russians completed their tests.

Mr. STRAUSS. Yes, but I would like to qualify that in view of what Senator Humphrey has said. I had assumed that this organization had just been organized. Apparently it has not.

Senator SYMINGTON. I am referring only to that one ad, that particular group. It is a group of some standing.

Mr. STRAUSS. I would not want to do these good people any harm. As I say, a number of them are my friends. I am sure they are sincere. I think they are misguided.

Senator SYMINGTON. They are fine Americans to the best of my knowledge. I saw some good friends of mine on the list.

EFFECT OF TEST SUSPENSION ON NATIONAL SECURITY

Based on your testimony this morning, you do believe this effort to sell public opinion to stop tests now—is against the security of the United States; is that correct?

Mr. STRAUSS. Yes. I fully concur, however, with the right of these people to so express themselves, and I am sure you do.

Senator SYMINGTON. And we do completely. We just want to be sure we get your testimony as Chairman of the Commission.

Mr. STRAUSS. That's right.

Senator SYMINGTON. And you do not agree that the testing to date is of such importance that stopping testing now should be considered; is that correct?

Mr. STRAUSS. That is correct, Senator.

IMPORTANCE OF NEGOTIATION

Senator SYMINGTON. Mr. Chairman, I would like to proceed to another problem incident to this overall situation. I had always felt that the chairman of this committee was on sound ground when he criticized our reaction to the Soviet nuclear test cessation proposal by packaging with it a cessation in production.

There can be an honest difference of opinion on this. It has been my experience in activities, for example, such as negotiating labor contracts, that when you stop talking, you don't get anywhere, and if it is serious you generally end up with a strike or something comparable thereto. I believe that we should have gone on talking. Although our people now go into Russia more than they used to, they still only see what the Russians want them to see.

If we had accepted this test cessation proposal and allowed several hundred of their people to come in here and we would have put several hundred of our people over there, even if we did not sign a deal—and of course we would never sign any agreement that we did not feel was in the interests of our country, don't you think that that would have tended to further reduce the height and depth of the Iron Curtain?

Mr. STRAUSS. Senator, I think one has to look at the history of these negotiations. They really began, as you know, in 1946, they are that old, when we offered in the plan which carries Mr. Baruch's name to put the whole atomic energy enterprise of the United States—as far as we knew then the Russians had none—under international control. They were unwilling to accept it.

There have been a number of alternate proposals made since that time, including the Russian proposal to ban the bomb by mutual agreement, that we should ban the bomb.

What I understand is now proposed is that we should accept their most recent proposal, which is to cease testing at a time when they have completed a series of tests when we are about to start a series leading to the development of a better defensive posture.

My apprehension as I expressed it this morning, is that if that transaction is limited only to testing, we will be at a disadvantage in that they will be able to continue to perfect the delivery system of the weapons they have, and we will be frozen in the present state of our art for interception.

Senator HUMPHREY. Will the Senator yield?

Senator SYMINGTON. I gladly yield to the Chairman.

Mr. STRAUSS. I am sorry my answer is so long.

NECESSITY OF INSPECTION

Senator HUMPHREY. I just want to get a clarification of this matter, because I believe the question which Senator Symington asked goes right to the heart of the information which we are seeking to obtain.

First of all, as we said earlier, I don't believe anyone in the executive branch has suggested in an official capacity that there should be a unilateral cessation of tests without inspection.

The whole heart and core of any proposal, whether it is from the President, the Secretary of State, yourself, or members of this com-

mittee, is the inspection and detection. The issue centers around whether or not an inspection system can provide an adequate protection for purposes of our security.

So on that point I think it should be made clear that Senator Symington was talking about the inspection of the cessation of tests, is that correct?

Mr. STRAUSS. I quite understand that, and in my answer I was assuming that that would be installed and that it would be effective.

Senator HUMPHREY. Yes.

Mr. STRAUSS. It would not, however, prevent and is not designed to prevent the continued work by the Russians on missiles, and we have not spoken about the cessation of anything except the testing of atomic weapons.

REASON FOR FAVORING PACKAGE PROPOSAL

Senator HUMPHREY. If the Senator will yield on that point, can I ask what is it that makes you willing to accept the package of test suspension, nuclear production cut off for weapons purposes and conversion of stockpile?

You said you were willing to support that because that was the position of our Government. What is there that makes you willing to accept that when the criticism that you have leveled against test suspension still prevails?

Mr. STRAUSS. I think that is a fair question.

Senator HUMPHREY. In other words, the technology would still be retarded. The Soviet might still attempt to cheat. All the doubts that you have are still in that package.

Mr. STRAUSS. That is true, Senator, but the price is a very important one. This would really begin nuclear disarmament.

Nuclear disarmament is not effective by the cessation of testing. Both countries would presumably continue to manufacture and retain their existing stockpiles of weapons, and as I have tried ineffectively to state this morning, that the danger which confronts the world is not the danger from testing. It is the danger from a nuclear war. A nuclear war cannot be fought without nuclear weapons.

IMPORTANCE OF WILLINGNESS TO NEGOTIATE

Senator SYMINGTON. If I may go back, I remember back in 1946 when I was Assistant Secretary of War, I was staying with General Clay in Berlin, and he was telling me that the methods of the Russians made it difficult to get along with them in normal relationships, and I said, "Give me an illustration of that."

He said, "Well, whenever you ask them a question they haven't got the answer for, they just put the phone down. They never say I don't know, and the telephone service here is very bad, so it takes quite a long time to get them back. By the time you get them back they generally have the answer. If you ask them can they meet at 5 o'clock that afternoon, a joint group, and they don't know the answer, they just put the phone down and then you go through this rigmarole to get them back on the phone."

You and I have been in business. Sometimes you start negotiations, you write letters and then you maybe get on the telephone

together and say, "Well, I think we had better meet in St. Louis and talk this over, we are getting pretty close."

It seems to me that when they said to us, "Well, we will negotiate a nuclear test agreement with you," that they were giving us an opportunity to get closer.

And when we said, "No, we won't do it unless you do a lot of things," which I feel frankly we can feel pretty sure they wouldn't do, and I think you do too, then we were really shutting the door on the first step to get closer to them, maybe to get on a telephone basis instead of a letter basis.

Mr. STRAUSS. Senator, as you say, that is the way we do business, but I would remind you that there was a negotiation at Panmunjom which went on for years, and the Russians would walk out on it. It was a person to person across the table negotiation.

I took a delegation to Geneva in the summer of 1955, members of the Joint Committee on Atomic Energy being there. In Geneva was Mr. Johnson, now our Ambassador to Russia, who had been sitting in Geneva for a period of months, and I believe 2 years prior to 1955—I would like to correct that time for the record—negotiating on the return of prisoners taken in the Korean war. That negotiation went on long after the Geneva conference ended, and I don't believe ever resulted in anything.

Senator BRICKER. It is still there.

Mr. STRAUSS. A person to person conversation across the table. It seems to me that staking out the parameters of this problem early is very important, and not to yield on the one point that the other party wants you to yield on, and then perhaps never get anywhere.

Senator SYMINGTON. But when you agree to discuss a deal, where is the yield?

Mr. STRAUSS. We have never said we would not discuss it.

VALUE OF DISCUSSION

Senator SYMINGTON. Didn't we say we would not consider nuclear testing agreement unless also with it we included the——

Mr. STRAUSS. That is my understanding, yes.

Senator SYMINGTON. Then we did, didn't we? We refused to consider the first step.

Mr. STRAUSS. This was the position of the Government. I happen to think it was a sound one and one might say that both positions were intransigent. But why we should yield instead of their yielding I don't know.

Senator SYMINGTON. Could we put it this way. Why should we not agree to their proposal to get closer just because we want to make them agree to some more things before we would even agree to take the first step with them? I think this is awfully important.

Mr. STRAUSS. It is very important.

Senator SYMINGTON. You gave us some very informative and constructive testimony this morning about our position from the standpoint of being prepared for defense. It has always worried me that we are like people in a house, with a man outside with a gun. You don't know whether he is going to come through the second floor, the cellar, the first floor, the back window or where.

It seems to me we have always been and are going to be in that position. But, on the other hand, if we are in the house and we don' want to shoot him, and we don't think that is right, if he wants to talk about things it seems to me we should talk.

Mr. STRAUSS. Yes.

Senator SYMINGTON. So long as we don't commit ourselves to anything that will affect our security as a country.

Mr. STRAUSS. I just think it does affect our security. It is like laying our pistol down to go into such a negotiation on that basis.

Senator SYMINGTON. You mean if we stand here with our pistols set to shoot, and they have theirs, and we go over and meet with them, and they come over and meet with us, I don't see the difference between saying you will lay your pistol down to talk like that any more than you lay your pistol down if you have a United Nations discussion.

Mr. STRAUSS. I don't know how to put it, Senator. In a business transaction, where I am a little bit more at home than I am in this field, I am very much more at home than I am in this field, if you concede all of the advantages that you have as preliminary to a contract it may not be worth the while of the other party to enter into the contract.

Senator SYMINGTON. Then you got into a sort of never-never land, where you just don't believe you can succeed, based on the past.

Mr. STRAUSS. No; but you at least——

Senator SYMINGTON. And if you do that in this situation, I think ultimately this country is going to be destroyed.

Mr. STRAUSS. You at least maintain your ability to defend yourself.

Senator SYMINGTON. I must say, Mr. Chairman, I have great respect for you.

Mr. STRAUSS. It is mutual, Senator.

Senator SYMINGTON. But I think we have to talk to these people at every opportunity.

Mr. STRAUSS. I agree.

Senator SYMINGTON. The people in that country don't know the truth about our situation over here, and I think that this time we missed a bet, and I say that with great respect.

Senator HICKENLOOPER. Will the Senator yield there just for a question?

Senator SYMINGTON. I will be glad to yield.

REASON FOR DISCUSSING PACKAGE

Senator HICKENLOOPER. Do I understand your position, Mr. Chairman, to be this: That if we go into a discussion where the only subject on the agenda today is the cessation of testing, then that is all that is going to be talked about, and the only result of that, if we agreed, would be greater disservice to the United States and our security in the future.

Mr. STRAUSS. In my opinion, sir.

Senator HICKENLOOPER. I say do I understand that?

Mr. STRAUSS. That is right.

Senator HICKENLOOPER. But if we go into a discussion and our position is that not only the cessation or stoppage of testing is to be discussed, but also the question of armaments, and perhaps the reduction of stockpiles, or something like that, that is when there are several subjects which can be used one to offset the other in some

degree, then perhaps we can have some hope of arriving at an agreement or an understanding which might be to the mutual advantage in various degrees of the contracting parties.

Mr. STRAUSS. You have stated my position, sir.

Senator SYMINGTON. I don't agree with that, I tell my friend from Iowa, because we certainly have great interest in this corporation over here. We watch with interest who runs it from week to week and so forth. And if they offer us 100 shares in it, I don't think it is smart to say we won't talk about it unless we get control.

Mr. STRAUSS. It is what you have to pay for the hundred shares, Senator.

Senator SYMINGTON. That is right, and I would be willing to pay a lot to get a little further look at the corporation. I think that sometimes when the market goes up and down rapidly, that people pay a lot for reasons that don't have much to do with actual value.

Senator HUMPHREY. Will the Senator yield at this point?

Senator SYMINGTON. I am always glad to yield to my chairman.

POSSIBILITY OF ESTABLISHING EFFECTIVE INSPECTION SYSTEM

Senator HUMPHREY. I wonder if the issue for negotiation is not the matter of what kind of inspection we are talking about. That is really what you are negotiating. It is not negotiating just the cessation of tests. You are negotiating the apparatus.

Mr. STRAUSS. I am assuming, Senator, for the sake of the argument, although I don't agree that it is possible, I am assuming an ironclad inspection.

Senator HUMPHREY. I see.

Mr. STRAUSS. I have said this morning that I think that is not possible. But to make the case clearer here, let's assume that it can be ironclad. It would still be a disadvantage to us, since they have the weapons necessary for aggression and we do not yet have all the types of weapons necessary for defense. That is really the difference.

Senator HUMPHREY. That is your position.

Mr. STRAUSS. Yes, sir. It may be an oversimplification, but I believe in it.

Senator HUMPHREY. Did I understand you to say also that you doubted that we could have an effective inspection system on the cutoff of the production of nuclear material?

Mr. STRAUSS. I said not 100 percent effective. I think we can have one that would be satisfactory, that I would describe as satisfactory.

Senator HUMPHREY. Would you be willing to negotiate that separately?

Mr. STRAUSS. Yes.

Senator HUMPHREY. That one item alone separately?

Mr. STRAUSS. Yes, of course, but I have grave doubts as to whether that would find any reception.

Senator HUMPHREY. Have you ever tried it? Has anybody ever tried it?

Mr. STRAUSS. I have never been at the negotiating end, it is out of my responsibility.

Senator HUMPHREY. The thing that keeps coming back to my mind, is that I was once taught that the whole is the sum of its parts, and you support the whole package?

Mr. STRAUSS. I do, Senator.

INSPECTION OF STOCKPILES

Senator HUMPHREY. But in the process you are opposed to two or three parts of the whole package. You say that you don't believe that we can cut off the cessation of tests. I thought you agreed with our distinguished witness of yesterday, Dr. Teller, that it is impossible to really inspect this stockpile.

Mr. STRAUSS. No.

Senator HUMPHREY. Don't you agree with that?

Mr. STRAUSS. The stockpile, yes. That is not included in these——

Senator HUMPHREY. Yes it is.

Mr. STRAUSS. No, I have not said anything about the stockpile. I said we do stockpile, but it is impossible to inspect for stockpile.

Senator HUMPHREY. That is right.

Mr. STRAUSS. As far as the present state of the art is concerned, we do not know how to identify the hiding place of a manufactured weapon.

Senator HUMPHREY. I agree with that, but it is a part of our Government's package that we are going to convert into peaceful purposes some of the stockpile when we don't even know what it is. In other words, we are talking fiction.

Mr. STRAUSS. No, it isn't fiction.

Senator HUMPHREY. We surely can't talk factually about it.

Mr. STRAUSS. We know that they have the stockpile.

Senator HUMPHREY. Well, how much?

Mr. STRAUSS. We can make an educated guess.

Senator HUMPHREY. How are you going to prove it?

Mr. STRAUSS. We can't prove it.

Senator HUMPHREY. Since you can't inspect it, there is no way you can verify that.

CONVERSION OF WEAPONS STOCKPILE TO PEACEFUL PURPOSES

Mr. STRAUSS. No, but they will have to be produced for this purpose. We would not contribute to such an arrangement more than an amount based upon some fair evaluation of what they contributed.

Let me remind you that in 1953 the President proposed that there should be a mutual contribution to the stockpile of fissionable materials for an international atomic energy agency, and he indicated that that would be on a reciprocal basis.

Thus far there have been I think contributions from four nations, ours being by far the largest. We have never contributed on the assumption that we would continue without limit unless the Russians showed some disposition to make substantial amounts available.

They have announced a small contribution, and have announced that as the need developed they would be prepared to allocate more. It is on some such basis as that that I believe such an agreement to convert stockpiles to fissionable materials would operate. That would be the pattern that I have in mind. There probably are better ones.

Senator HUMPHREY. We would have to rely upon the honor of both parties, would we not?

Mr. STRAUSS. Yes, except for this. If we produced and they did not produce the first amount, there would be no second. We have produced an amount, have offered an amount of fissionable material to the agency.

NECESSITY OF NEGOTIATION

Senator SYMINGTON. I would like to just close that part of it as far as I am concerned by saying with great respect to you, sir, that I have often entered labor negotiations or a business deal where I thought the chances of success were nil, and yet there are times when it worked out very well to the satisfaction of both parties.

And because of what I think Mr. Churchill recently called the theory of mutual terror, I don't see how we can let the past affect the willingness to negotiate for the future.

It may very well affect the nature of the deal we want to make, but I don't see how it could affect our willingness to negotiate. I would hope this Government, every chance it gets to talk with these people, so long as our dignity and our pride in our Nation is not involved, would take that chance.

Mr. STRAUSS. Senator Symington, I am under the impression that we have never refused to sit down with them, that they have refused to sit down with the subcommittee on disarmament of the United Nations, or walked out on it. I don't know which, but unless I am mistaken, the United States representatives have never walked out on or declined to discuss disarmament with the Soviets.

Senator SYMINGTON. I do not think that is correct.

As I understand it, the Soviets did offer a situation in the way of discussion of nuclear test cessation, and that we refused to even discuss that unless along with it we discussed the cessation of production.

Now based on the testimony that we received from the Atomic Energy Commission, I think it is fair to say that we set up barriers which we ourselves did not feel could be solved. And therefore I don't feel honestly that we have the right at any time because of our way of life and form of Government, to refuse to talk with these people. We sure have every right in the world to decide whether any deal we make as a result of those talks is a satisfactory deal.

SIZE OF NUCLEAR WEAPONS TEST WHICH CAN BE DETECTED

May I proceed to read a little from the testimony of yesterday. I have two more subjects, Mr. Chairman. I said to Dr. Teller:

Doctor, you said small bombs can be hidden and big bombs can be detected. The people like to know these things. They will make the final decisions. They are the people whose future is at stake.

Why do we have to be so secret about some of these problems? Can't you tell us how big you think a bomb can be before it can be detected?

Dr. TELLER. Sir, I wish I could. As far as I know and maybe I am overcautious, but as far as I know the regulations are that at this point I must not answer in open session.

I would be happy to mention it, but at present I could give you these figures, unfortunately, only in executive session.

I asked:

Who makes the regulations?

Dr. TELLER. I think you, sir.

Then the distinguished Senator from New Mexico, the chairman of the Joint Atomic Energy Committee, said:

What is the answer, Doctor?

Dr. TELLER. I think the Congress of the United States makes these regulations.

The Senator said:

You had better look into that a little bit.

Dr. TELLER. I may be mistaken. I believe that the Atomic Energy Commission merely interprets them. I might be completely wrong, sir.

Senator ANDERSON. I can just assure you that you are 100 percent wrong.

I think at that point I said we would ask you about the matter when you came here today.

Mr. STRAUSS. I think there are two different approaches to it, Senator Symington. I would have answered, not having heard Dr. Teller's answer, that we don't know. We have only shot one test underground, a weapon of 1.7 kilotons yield.

I think it would be necessary to conduct both larger and smaller tests before an answer could be made. Whether this involves restricted data or not—Dr. Marshall, who is in charge of classification for the Commission, tells me it does not.

Senator ANDERSON. What?

Mr. STRAUSS. It does not. But I would like to applaud Dr. Teller's respect for the fact that if he had any doubts about the classification of the information and he did not have Dr. Marshall at his elbow, he was right to be careful. Information once compromised unfortunately cannot be recovered. It is an experience we have had. I would rather err on the side of care and declassify it later.

ORIGIN OF SECRECY REGULATIONS

Senator SYMINGTON. I would like to ask the question that was sort of implied yesterday. Who made the regulations, the Atomic Energy Commission or the Congress?

Mr. STRAUSS. The Congress prescribed the guide rules. The Atomic Energy Act defines restricted data.

Within the definition the Commission is responsible for the writing of the so-called declassification guide or classification guide which prescribes the kind of information, the specific items of information, the categories of information involved in restricted data.

Senator ANDERSON. Would you yield to me there?

Senator SYMINGTON. I will be glad to yield.

Senator ANDERSON. The question asked Dr. Teller was, Can he tell us how small or how large a bomb would have to be? Will you quote me the provision of law by which the Congress has shut his mouth?

Mr. STRAUSS. Senator, I did not say that there was a provision of law that shuts his mouth.

Senator ANDERSON. You just now answered the specific question stating that Congress had imposed that limitation. Will you tell me where?

Mr. STRAUSS. No, Senator.

Senator ANDERSON. Let's get the question. What was his answer?

(The reporter read back the answer.)

Senator ANDERSON. You started with "The Congress prescribes the guide rules." The question was asked did the Congress do it or the Atomic Energy Commission do it, and your answer was the Congress prescribes the guide rules.

Mr. STRAUSS. The guide rules.

Senator ANDERSON. Quote me the language of the law which says he can't say how large or small the bomb is.

Mr. STRAUSS. I can't quote you that, Senator.

Senator ANDERSON. Because it doesn't exist.

Mr. STRAUSS. No, I haven't said that he couldn't. I said that one of the reasons he couldn't is because it is unknown.

Senator ANDERSON. That is a little different matter. If it is unknown, the Congress hasn't made it impossible to talk, has it?

Mr. STRAUSS. I haven't said the Congress made it impossible.

Senator ANDERSON. The Congress isn't responsible for lack of information, is it?

Mr. STRAUSS. I don't believe there is any lack of proper information, Senator.

Senator ANDERSON. You said he couldn't answer because he didn't know. Is that the Congress' fault?

Mr. STRAUSS. No, Senator, it is not the fault of the Congress.

AVAILABILITY OF INFORMATION

Senator SYMINGTON. Admiral, I have one other subject that I would like to bring up with you. Pardon me for changing your title periodically.

Mr. STRAUSS. I am quite used to it, Senator.

Senator SYMINGTON. I have known you in both fields.

Mr. Chairman, the American people—and I believe you will agree with me on this—are all mixed up on this subject. They want to do what is right.

They do not want to ruin themselves by having these tests, if it is true that these tests are going to destroy them or change the shape and minds of the future generations, and so forth. Everybody is mixed up on it. We have had testimony here by so-called authorities which has been fantastically different.

Now what worries me is that the people who have access to all the information are the people who seem more prone to resist any unilateral action on our part. They also seem to be more prone to strike down the dangers of worldwide fallout at all times, and I emphasize I am not talking about local fallout.

The people who have given us information and warned us about the dangers of poisoning the world, and so forth, are people who are not even cleared in important cases to get the information that you have available to you and that your Commission has available to it. For example, Mr. Harrison Brown told us that he was not cleared for information, and yet he has taken a position in all sincerity—I am sure he is a fine American—and he has taken a very definite position.

Now yesterday we had Dr. Orear from Columbia University, who made some statements that were at complete variance with much of the testimony that has come from you and your advisers, and some of your own technological experts. I thought that it would be a good idea, and I suggested it to Dr. Orear, that we ought to get this thing thrashed out.

DECLASSIFICATION OF INFORMATION

You can't even place a bet the way things are going now. And so Dr. Orear made a very interesting observation. I said:

In other words, let's get people like you and Dr. Brown cleared right away so you can go in there and discuss this whole question of the danger of testing, which is the basis of the testing program, and which in turn is the basis of disarmament progress. Then you could discuss these things on a completely "here is all of the information" basis with those people who are cleared.

You see the implication, that we come out with something that the people could get their teeth in that would be a consensus of opinion. Dr. Orear said:

I would much prefer it if some of this crucial information could be cleared, if the information could be cleared rather than me being cleared.

If I were cleared, I would not be able to give you the public testimony that I have given you.

That is rather interesting, you see, because you can see that he is saying:

If I were cleared I could not give you the truth. I would not be in a position—

Mr. STRAUSS. He happens to be mistaken.

Senator SYMINGTON. Just let me finish the thought.

Mr. STRAUSS. I beg your pardon.

Senator SYMINGTON. He says, in other words, "If I am taken into the club, I am not allowed to give the truth to the people. Therefore I would rather stay out of the club so I can give the truth to the people."

Now you say he is out of the club and he is not giving the truth to the people?

Mr. STRAUSS. No, I haven't said that about him because I haven't the slightest idea what he said.

Senator SYMINGTON. Well, you have said it. In other words, you have said some of his statements were not correct.

Mr. STRAUSS. No, I only heard his statement to the effect that he had said he could hold 140 pounds of plutonium in the palm of his hand, and I haven't seen him.

Senator SYMINGTON. I have great respect for both of you, but some of your testimony denies his testimony, and presumably you are telling us what you think is the truth.

Mr. STRAUSS. Only that.

FREEDOM TO DISCUSS PROBLEMS

Senator SYMINGTON. I know that, and you know that I know that. But, your testimony disagrees. Now I repeat again what he said:

If I were cleared, I would not be able to give you the public testimony that I have given you. I would not be able to talk about this fuzzy dividing line being in the region of a kiloton. You saw how the previous witness was quite handicapped.

I have just read you about the previous witness saying frankly that somebody had put some shackles on him, regardless of whether it was you or us. Now this Dr. Orear continues:

The advantage I have now is that I can discuss many of these things freely in the open public and open press, and I think there must be some people who still have this freedom, and I have found this to be a considerable advantage, in order to serve this purpose.

He says:

If I had this clearance, I would not be able to talk about many of these things in public and present some of these facts to the public.

Mr. STRAUSS. May I comment on that?

Senator SYMINGTON. I said, "I would like to see the record on that tomorrow," so that we can discuss it with you.

Senator HICKENLOOPER. Will the Senator yield there?

Senator SYMINGTON. I will in just a minute. We are getting ourselves into a right tricky situation here, aren't we?

Mr. STRAUSS. Yes. I believe that the law applies to people who have been cleared, people who haven't been cleared, to American citizens generally. I think it protects restricted data irrespective of whether a person has been cleared or not.

And while it is difficult to comment on Dr. Orear's testimony without having read it, and unfair to him, so I shan't comment on it, I suspect that there is a misapprehension here.

There is no barrier on anyone's discussing unclassified information, and the fact that a man might be an employee of the Commission and cleared or an employee of an industrial firm uncleared makes no difference.

There are some men, and I don't know whether it applies to either of the two who have been mentioned, Dr. Orear and Dr. Brown, who elect not to work in Government work that is classified. They just prefer not to, and their views have to be respected. A man who doesn't want to do that can't be made to do it in this country, thank God. And it isn't always because a man is not cleared for security reasons. It may be his own election.

DISTINGUISHING BETWEEN CLASSIFIED AND PUBLIC INFORMATION

Senator HUMPHREY. Senator, would you permit this interruption? Let me describe what disturbs me about this. I am not drawing any value judgment, but just giving you the situation.

Here you are, sir, the Chairman of the Atomic Energy Commission, speaking in public session. You have talked about a great deal of material that I have heard in executive session.

I don't say that everything we have heard in executive session is always executive, but what you have said here today has been in some instances said in other ways by some of your associates, which is understandable, since you work so closely together. Dr. Teller is one of your most illustrious scientists. He works very closely with you.

Mr. STRAUSS. One of the Nation's, one of the world's.

Senator HUMPHREY. He is one of the world's most illustrious scientists. He gave us more information of a technical nature yesterday than we have heard in almost any executive session.

But by the same token, Dr. Hans Bethe comes in this morning and we asked him whether he could testify in public session, and he said "No." His testimony is at variance with Dr. Teller's, and it is at variance with yours.

Now much of it is similar, don't misunderstand me, because you heard some of it yourself. There is a great deal of similarity.

But when it comes to some of the value judgments, when it comes to the evaluation, and he is the chairman of an evaluation committee, his testimony is different from the evaluation that you make.

DIFFICULTY OF GETTING FAIR PICTURE

The problem is that the public may never get what Dr. Bethe says. Every time there is anything that can support his evidence, somebody can just mark an X through it, and say, "That is classified."

How can you win this argument? This is like people being able to change the spots in a card game. You can't possibly have a trump and you can't possibly win a play, if somebody wants to play it that way.

Mr. STRAUSS. As you know, I had this misfortune to hear only a small part of Dr. Bethe's testimony. When you put a question to me near the end of the session, I said that on technical matters I would be almost certain to agree with him. On matters of deduction from the facts as stated, I thought there was room for difference of opinion.

Senator HUMPHREY. Yes.

Mr. STRAUSS. I believed that I was right. That is only human.

Senator HUMPHREY. I don't disagree with that at all. I think you are being very fair about that.

All I am saying is that it is going to be very difficult for the people to know on what technical facts Dr. Bethe ever made his judgment, because these technical facts are going to be crossed out of the testimony.

Now the same thing would be true, may I say, of Dr. Scoville, who came in and whose testimony is different from Dr. Teller's.

Mr. STRAUSS. Let me cast modesty aside and say that in 1949 I found myself at variance with a very distinguished group of scientists on a question of whether a thermonuclear weapon could be made, whether it was advisable to make it, and I was very much concerned at the fact that I should be that much out of step.

Well, the passage of events has confirmed the importance of the minority point of view, and therefore I am a little bit reinforced in my feeling that on a value judgment as contrasted with a technical difference of opinion, one does not necessarily have to concede error if one is in the minority.

Senator HUMPHREY. Again I want to say that I am not disputing your right to say what you say, nor am I disputing the fact that you may have very good evidence to support what you say.

All I am saying is that the format, the procedure under which we have to work, is rather unfortunate. We get what we call restricted material on the part of subordinates; then, the Chairman of the Commission comes up and the leading scientist comes up, and they are very open in public. Obviously, this influences public opinion just like I think some people who do not have access to classified information, and therefore may not always have all the facts, may influence public opinion.

You have made a judgment about testing. You have a definite point of view. Your point of view is that to cease testing would be injurious to the national interest.

Now it could be presumed by some who want to be a little bit suspicious that you might want to organize material to support your position, and the only way that that could be disputed in the market place of ideas would be to afford somebody else with the same information that you have, the same right to testify without restriction.

Mr. STRAUSS. Senator, I think I have a complete answer for you.

Senator HUMPHREY. I hope so.

Mr. STRAUSS. No. 1, I advocated that Dr. Bethe's testimony should be in open session, and I so told Senator Symington on yesterday in the course of a conversation.

No. 2, it was arranged this morning that we would review his testimony in order to extract from it any highly sensitive matter so that the balance might be published.

Senator HUMPHREY. We have made great progress in this. I am very delighted, I am very pleased, because the pressure has been on to get more open information.

Senator SYMINGTON. I would like to yield to Senator Hickenlooper.

SIMILARITY OF TESTIMONY

Senator HICKENLOOPER. I want to have the floor for a minute, because I did not want my silence to indicate that I was in complete agreement as between Dr. Teller and Dr. Bethe. I did not hear Dr. Teller's testimony yesterday. I read résumés of it. I did hear reference to it in executive session this morning.

I heard Dr. Bethe's testimony, and it is my distinct understanding and my opinion that there is no great difference between Dr. Bethe's views and Dr. Teller's views on most of these issues.

There is one item which I shall not mention here where there was a disagreement as a matter of degree. The basic principle was approximately the same. There was a disagreement on the matter of degree in this particular situation, and that is as I recall it the major divergence.

Senator SYMINGTON. I can't agree with that, Senator. I don't think I am releasing any secret information, but Dr. Bethe says he personally feels we should go ahead with nuclear cessation of testing without tying it up with production, and Dr. Teller says that we should not. Now if that is a difference of degree, then $4 and $5 are the same thing.

Senator HUMPHREY. Didn't Dr. Bethe also say that it would be to our advantage technically?

Senator SYMINGTON. Now you have me worried as to classified information.

Senator HUMPHREY. That is not classified.

Senator SYMINGTON. I think that the difference of opinion between Dr. Teller and Dr. Bethe was a difference of kind and not a difference of degree.

Now, Mr. Chairman, just to show you the problems with which we labor and to illustrate why I felt that you would not agree with Dr. Orear's testimony, he said:

> We all agree that nuclear explosions can be made so small as to be undetectable, but such devices will not make practical weapons.

Mr. STRAUSS. I respectfully differ with Dr. Orear on the technical matter then. There I suspect that he is speaking without full knowledge of the facts.

Senator SYMINGTON. That is my point, but he comes down here as a Professor of Physics of Columbia University, a member of the Columbia University Inspection project, which gets into this whole fallout question that we are discussing. He is considered to be an authority, and if he is right, the whole theory of our NATO defense as I understand it is wrong, the theory of dispersion, of the pentomic division and so forth.

CLASSIFICATION POLICIES

Why don't we do like we do in the patent pools. When I was in business in the dear dead days, and we finally got a patent pool and we began to make a little money, and everybody began putting their patents in the pool with this promise.

They were sold the idea that their laboratories weren't better than everybody else's laboratories combined, and so they all got together and worked together, and industry turned from an unprofitable one to a profitable one.

I might add that the Commission has always been very fair in giving Members of Congress information on the basis of the right to know. But why do we get into this secrecy racket to a point where the American people are completely befuddled over something that is absolutely vital to their security?

In our form of government the people are the final deciders, and yet how today, the way this thing is being bandied around in advertisements, in closed hearings, in open hearings, in magazines, by experts or would-be experts, so-called experts, how can we make the right decision?

And if we make the wrong decision, I know you will agree with me we may lose the country. Isn't there some way we can lift this secrecy veil off?

Mr. STRAUSS. Senator, I think I can answer this. I hope I can answer it to your satisfaction.

First, let me say that in the past 5 years the Commission has declassified 69,512 secret reports, secret and top secret, and has downgraded, reduced in classification, another 9,533. The Commission has announced practically every Russian shot as it was detected.

When I say practically everyone, there was a period of a year or so ago when they were coming quite frequently one after another, and I think I issued a statement saying that we would only announce individual shots if there appeared to be a substantial difference in tremor or something new or unusual.

I don't believe that the Commission today is keeping from the American people any information essential to this decision, but I have this kind of a recommendation to make to Senator Anderson and Senator Bricker and Senator Hickenlooper:

That if the Joint Committee which is fully informed to the best of our ability and its staff feel that we have information or have transmitted to them information that should not be kept within the breast of the Joint Committee, and will so indicate to us, we would undertake to release it. I don't believe we are keeping from the American people anything except essential defense information, a knowledge of which would benefit the enemy.

Senator SYMINGTON. Well, but you have a problem as a public servant, have you not?

Mr. STRAUSS. Yes, I do.

Senator SYMINGTON. Which is to be sure the people are not misled.

Mr. STRAUSS. That is one facet of the problem; and the other is to be sure that no information which will injure the people reaches an enemy of the people.

Senator SYMINGTON. I understand that. But today, the people are very badly mixed up on this whole problem. Do you think that is because of the law?

COMPLEXITY OF SECRECY PROBLEM

Mr. STRAUSS. No, sir. I think, in the first place, it is because of the complexity of the subject. It is because up until a very few years ago, polls which had been conducted indicated that people were reluctant to know about it. And it is, in the third place, due to the fact that there has been a great deal of misinformation circulated, part of it accidentally and part of it quite deliberately.

Senator SYMINGTON. Have you any suggestion as to what could be done to get this matter more clearly, with greater clarity, before the American people so that they could have a better chance of forming their decision on the basis of what the facts are?

Mr. STRAUSS. Well, I think the thing to do is to have servants in the Government who do what they are sworn to do; and if you do not have people who will carry out those functions, to replace them by others who will.

Senator SYMINGTON. I do not like to get into the question of personalities, and I know you are aware of my high regard for you. But I know, we both know, that the people are all mixed up about what fallout does, and about the whole question of the cessation of nuclear testing, and so forth and so on.

I believe it is fair to say the administration has changed its position slightly, at least recently, at the top.

I was just hoping, Mr. Chairman, that you might have some ideas as to how we could get this matter further clarified. I will not pursue it. It is a source of regret to me that the people are bewildered by the various messages they are getting from various quarters.

I want to thank you for your tolerance and cooperation with my questions.

Mr. STRAUSS. Senator, this gives me the opportunity to express my gratitude to you for a long-standing friendship.

Senator HUMPHREY. Senator Bricker?

Senator Wiley?

PROBLEMS IN TEST SUSPENSION AGREEMENT

Senator WILEY. I heard the distinguished gentleman's statement this morning, and I want to compliment him. I think his statement stated pretty well my own convictions on the subject.

As to the people, I find that all of us know very little about this subject. There is a general feeling that fallout would be a very dangerous thing.

On the other hand, the people who think, I am sure, appreciate your conclusion and the conclusion of the gentleman who testified this morning, that so far as we are concerned we cannot let our guard down. We cannot get into a position like we were even before sputnik, and certainly not like we were before Pearl Harbor.

In other words, the world is pretty small, and the Soviet Union is only a matter of minutes away now. That is the important thing.

As to a test suspension, I understand it is your judgment and the judgment of others that the Kremlin has made undoubtedly a number of experiments, and that what we want is to make some experiments and get some knowledge which we think we should get before we go ahead, possibly, and enter into a test suspension agreement. One problem would be, if there was an agreement, whether there could be an adequate inspection.

The next problem is whether or not, from our own experience, we can feel that the Soviet Union can be trusted or will keep the agreement.

Thinking that mere agreements will bring peace, however, is in the nature of a sleeping powder to a lot of people.

As I have said before, it was the Kaiser who said a treaty is but a scrap of paper. Moral responsibility is the main thing, and I am satisfied that a very brief statement prepared by yourself and others on one page, showing what the issues are, would help clarify the issues before the people. The people would agree that we should have this next series of experiments, which would probably reach into the latter part of the summer, and then go ahead with a possible agreement along the lines that have been testified to. We could see if such an agreement can be worked out.

We have seen already that the Kremlin has not been willing to agree to an agenda, according to the transactions that we are about to enter into now. We will see whether they will agree to an agenda such as the President wants. If they will not, how are we going to get an agreement with adequate inspection? And what constitutes adequate inspection? All those things have to be ironed out, and I am sure that in ironing them out the people will get a better understanding. I am sure you are contributing to it, sir.

DETECTION OF UNDERGROUND EXPLOSIONS

Senator HUMPHREY. Senator Anderson.

Senator ANDERSON. Mr. Chairman, on page 8 of your statement you say:

> I believe that with regard to tests conducted on, above, or under the surface in the territory of a specific nation, a properly designed monitoring system can detect those of larger yield. The monitoring system required, however, if that yield of detectability is to extend down to smaller shots, will be complex.

Would you define what a "larger yield" would be, and what a "smaller shot" might be, in terms of kilotons?

Mr. STRAUSS. I would like to do that in executive session, or to try to do it in executive session, Senator.

Senator ANDERSON. Outside of executive session, can I ask you if you regard the Rainier shot as a small or large shot?

Mr. STRAUSS. A very small shot.

Senator ANDERSON. It is 1/100 of 1 percent of what we could possibly have in being or could construct very quickly, is it not?

Mr. STRAUSS. I would not want to answer that, either, Senator, in open session.

Senator ANDERSON. Well, the Russian shot that was conducted on about the 25th of March, did the Atomic Energy Commission announce the size of that?

Mr. STRAUSS. On the 25th of March?

Senator ANDERSON. About that time.

Mr. STRAUSS. I do not think that was a nuclear shot, Senator, and it was not announced as such. I would like to check.

Senator ANDERSON. I did not say it was announced as a nuclear shot. There was an explosion on the 25th of March, and did the Atomic Energy Commission not announce the number of kilotons in it?

Mr. STRAUSS. I don't believe so.

Senator ANDERSON. What is that?

Mr. STRAUSS. I do not believe so.

I do not think the Atomic Energy Commission announces any events except events which we identify as nuclear.

Senator ANDERSON. Let us put it this way: You detected the shot, did you not?

Mr. STRAUSS. The shot was detected.

Senator ANDERSON. Yes. And the Russians announced this was 3 kilotons. Was there anything in your experience to persuade you it was not 3 kilotons or thereabouts?

Mr. STRAUSS. Senator, I am sorry to say that I do not know the answer to this. This was not defined as a nuclear explosion, and I paid no attention to it as being outside of my province.

Senator HUMPHREY. Senator, I just checked on this. The Soviet press announced that explosion was 3.1 kilotons. We got the information that an explosion had occurred, not from the Atomic Energy Commission, but from the Coast and Geodetic Survey. It surprised me that we did not get it from the Atomic Energy Commission.

Mr. STRAUSS. No, sir; I should not think it would, Senator. It would not be the responsibility of the Atomic Energy Commission to inform the committee of events inside the Soviet Union which were not related to our responsibilities.

Senator ANDERSON. But the chairman of this committee and other members of it had been very much interested, I know, in the possibility of detection. I believe some reference was made here yesterday to Governor Stassen, and of the possibility that there had been a recommendation of maybe 10 stations which would pick up this information.

If the 3 kiloton blast could be detected by our system when it was fired in the air, and a 1.7 kiloton could be detected 2,350 miles away, we do have some ability to pick up what might be called smaller shots, do we not?

SEISMOGRAPH OF RAINIER UNDERGROUND TEST

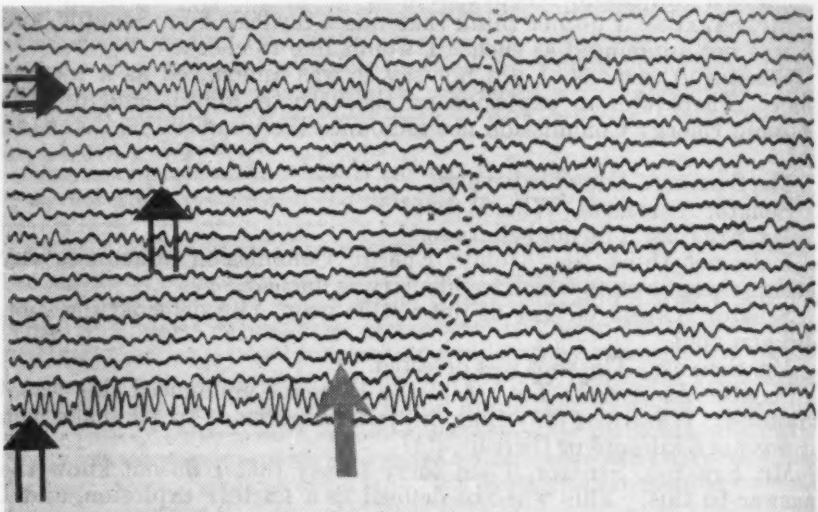
Mr. STRAUSS. The detection of the Rainier shot at a considerable distance, in Alaska, was possible only due to the fact that they had been alerted to the day and moment of its detonation.

Senator ANDERSON. You mean the fact that the man who was watching the machine knew that it was coming——

Mr. STRAUSS. Yes, sir.

Senator ANDERSON. Would have made a difference in the way the lines were registered in the seismograph?

Mr. STRAUSS. Yes, Senator. I was under the impression that you would ask this question, and I brought with me a photograph of the seismic chart from which you can see this for yourself.



RAINIER SEISMIC SIGNAL

RECORDED AT FAIRBANKS, ALASKA

On this chart is shown a section of the original seismographic chart from the Coast and Geodetic Survey station at College, Alaska. This one is the most sensitive in the Coast and Geodetic Survey's network, and is one of the two stations beyond about 650 miles which reported usable seismic signals from this shot.

The seismic signal from Rainier is indicated by the solid arrow, and I am informed by the experts is of a character——

Senator HUMPHREY. Just a minute, Admiral.

Mr. STRAUSS. Sir?

Senator HUMPHREY. The last time I saw this chart, it was secret. Is it secret now?

Mr. STRAUSS. No, sir; it has been declassified. I did not know it had ever been secret.

Senator HUMPHREY. It was submitted in secret session the last time we were here.

Mr. STRAUSS. Well, all material submitted in a secret session, Senator, is not necessarily classified. This chart is not classified.

Senator HUMPHREY. I just wanted to be sure. There was a photographer here.

Mr. STRAUSS. Yes. Undoubtedly the same kind of signals were received on seismographs in many other places.

EXPLANATION OF SEISMOGRAM

I am informed by the experts that this signal would have been reported as a small earthquake had not the Atomic Energy Commission given advance notification of the location and probable burst time, followed by exact coordinates and time after the burst.

Each of the horizontal tracings that runs across this chart is separated from the next by 15 minutes. One minute of recording is covered by the width of this graph.

It is interesting to note that there is evidence of three other earthquakes on the portion of the record shown. On the fourth line from the top, about 3 hours earlier, is part of the arrival of one phase of a small disturbance, believed to have occurred in the Aleutian Islands.

On line 8, about 2 hours earlier, is evidence of another small earthquake not identified as to source.

And on the second line from the bottom, 30 minutes later than the Rainier shot, is the record of compressional waves believed to have been produced by a small to moderate sized earthquake located in the Tonga Islands, 19 degrees south of the Equator, and about 6,000 miles from the station.

This disturbance was recorded by some foreign stations, and erroneously identified by these stations with the Rainier test. The subsequent epicenter determined by the Coast and Geodetic Survey placed the source of the disturbance in the Tonga Islands rather than in Nevada.

The interesting thing to me—I do not know anything about seismology—is the fact that the signals are very much more noticeable and very much stronger from these earthquakes than they were from the shot, which had to be identified by the station only by reason of the fact they had been notified when it was coming.

Senator HUMPHREY. May I ask whether it was shot on schedule?

Senator ANDERSON. The first two times failed.

Mr. STRAUSS. It was delayed the first time, but reannounced so that they had the indication of when to expect it.

AEC PRESS RELEASE ON RAINIER TEST

Senator ANDERSON. You were looking very hard for this, and the area in Alaska was watching for it, and did detect it, and it was known here that they had detected it. Do you think the newspaper advertisement which Senator Symington called your attention to, which he thought was misleading, is any more misleading than the press release of the Atomic Energy Commission on the Rainier shot?

Mr. STRAUSS. Senator, you were out of town on an errand of mercy, but had you been able to attend the meeting of the joint committee on the 15th of March at which this subject was discussed by the joint committee with representatives of the Commission, you would have seen that and would have heard that those committee members present, including the chairman of the committee, completely exonerated the

Commission from any intent to deceive. I was out of Washington, too.

Senator ANDERSON. I not only am familiar with the hearing, I read it word by word and checked it with people who are familiar with all the facts. Actually, I read an editorial which said that the point was that the Joint Congressional Atomic Committee, after investigating the matter in an unusual hearing last Saturday, reached the conclusion that the whole business boiled down to nothing more than an unquestionably honest human error.

I have searched the minutes of the Joint Committee and find no such decision in it. But that is a mistake that was made there.

I would like, if you do not mind, to go through some of the steps with you and again repeat with you——

Mr. STRAUSS. I would like to read you Mr. Durham's own language:

I feel it was an honest error——

he said.

Senator ANDERSON. You said it was an unusual meeting on Saturday, and I on an errand of mercy. A newspaper columnist had run a column saying that,

Representative Chet Holifield of California has now made a formal request for a hearing in which Senator Clinton Anderson of New Mexico is joining him.

We left town at about 1:30, and the announcement was made that we were going at 11 o'clock in the morning on that Friday ahead of this Saturday. Have you any idea when the Atomic Energy Commission notified the Joint Committee they would like to testify on this?

Mr. STRAUSS. No, sir. I was out of the city as well.

Senator ANDERSON. You were in the city at the time the meeting took place.

Mr. STRAUSS. I reached the city that morning. I did not attend the meeting.

Senator ANDERSON. Was there any relationship between the fact that Mr. Holifield and I were out of town, and the holding of the hearing?

Mr. STRAUSS. Senator, I think that is beneath you. I know nothing about——

Senator ANDERSON. I only point out that it was suddenly called when we were leaving.

Mr. STRAUSS. I had nothing to do with the calling of the meeting. I was away on a holiday, the first I had had in a long time. The whole event took place—I do not know who called the meeting. I assume the chairman of the committee.

Senator ANDERSON. I assume the chairman of the committee pointed out they could receive information. I just wondered if you happened to know when the Atomic Energy Commission offered to come up on Saturday.

Mr. STRAUSS. I do not know. I reached town by air Saturday morning. I don't know what time the meeting was held.

ORIGIN OF ERRONEOUS PRESS RELEASE

Senator ANDERSON. The background piece was written by a man named Henry G. Vermillion——

Mr. STRAUSS. I don't know him.

Senator ANDERSON. Who is a deputy director—I am about to enlighten you—who is Deputy Director of Information at Albuquerque. Mr. Richard G. Elliott—I am sure you know him——

Mr. STRAUSS. I do.

Senator ANDERSON. —Director of the Office of Information, directed Mr. Vermillion to cover the seismic effects and the background piece. Mr. Elliott—I met him at Denver at the airport as we were going to the Dempsey funeral—was quite upset and worried about coming in here so suddenly for this hurried hearing. He arrived in Washington in plenty of time for the hearing, and was he put on the stand as a witness?

Mr. STRAUSS. He was not. I can assure you, though, that had the joint committee desired to hear him, he would have been put on the stand as a witness. We never withheld a witness.

Senator ANDERSON. I assure you had I been in town, he would have been put on as a witness.

Do you have any idea as to what instructions he gave Mr. Vermillion in the writing of the background piece?

Mr. STRAUSS. I never heard anything—Senator, all that I know of this incident is in a memorandum which was introduced into the record of the hearings by General Field, and in a letter which was written to Senator Humphrey by my colleague, Dr. Libby, and which also appears in the transcript of the hearing and which, if you wish me to do it, I will be glad to read into the record.

Senator ANDERSON. I have read it over and over again, and I assure you, Mr. Chairman——

Senator HUMPHREY. Would the Senator yield?

It seems only appropriate, since the letter of Dr. Libby was placed in the transcript of the joint committee hearings, that the letter which I wrote to Dr. Libby might also be included. I must say in all candor, my letter to Dr. Libby was written in the spirit of charity and friendship, and not of accusation. I was not trying to prove the Atomic Energy Commission was up to anything. I wanted to point out only one thing, namely, that there was some evidence to the contrary of their report. I said that I felt the Atomic Energy Commission's responsibilities were such that the accuracy of their statistics was very, very important for the public. I wanted to call this to their attention.

Mr. STRAUSS. I hope that you will put the letter in, Senator.

(The letter referred to follows:)

MARCH 20, 1958.

Hon. W. F. LIBBY,
Commissioner, Atomic Energy Commission,
Washington, D. C.

DEAR DR. LIBBY: As chairman of the Subcommittee on Disarmament, I want to thank you for your appearance before the subcommittee on March 6. Your testimony, which I have since seen, was extremely enlightening and constructive. I understand that much of what was released had been previously classified and for that reason the subcommittee and the public must be especially indebted to you for your efforts to make the information available.

I also wish to acknowledge your letter to me of March 12 regarding the unfortunate error contained in the Commission's press release of March 6. The record of the events leading up to the issuance of the March 6 release indicates that the error was, as you termed it, inadvertent. The record does seem to suggest, however, that this incident would not have occurred if the Commission had been sufficiently sensitive to the importance of the detection of nuclear tests to any future arms control agreement.

I would like to emphasize that it has not been my purpose to have a debate or argument with the Commission. An examination of my statement to the Senate on March 11 will show that what I sought to do was underscore the necessity of having all reports of the Atomic Energy Commission relating to the matter of test detection be factual, complete, and comprehensive in their analysis and scientifically objective.

As I understand the organization of functions within the Commission, the matter of test detection comes under the Division of Military Application. This division's primary responsibility is the development of nuclear weapons and the problem of test detection appears to be of secondary concern. The director of the division confirmed this at the March 15 hearing of the Joint Committee on Atomic Energy. The director said at that time:

"The task of the laboratory and of our forces out in the field was to analyze the effect as [the explosion] might do damage close by. This was our only real interest at that time in the effect of a quake or shock. * * * We were looking therefore to try to find out what was the scale of the shock, how big it was with respect to an earthquake. We took certain significant records, generally records that were close in, records which were within 110 to 350 miles that showed clearly a signal, and we analyzed these with the objective of coming up with a measure of the shot. Therefore, personally, at the time I heard the remark (about the test being detected in Alaska) before the (Joint Atomic Energy Committee) I did not take this to be of any great significance to what I was trying to achieve * * *."

It occurs to me, therefore, that perhaps the division of military application with its concern with weapons development is not the appropriate division of the Atomic Energy Commission to have responsibility for test detection matters. I respectfully suggest that this be a subject of further consideration by the Commissioners.

A second question regarding test detection relates to the work of the many qualified scientists who were associated with the Rainier explosion. According to the report of the Radiation Laboratory at the University of California on the "Rainier Shot," one of the technical objectives of the test was "to measure and evaluate seismic signals and effects at distances extending from the point of detonation out to all distances where the signals could be detected." Since this was one of the objectives of the test, I believe it would have been helpful if the report had discussed in greater detail the seismic signals. For example, press reports of the test of last September indicated some 600 seismic stations were alerted to the fact a test was about to take place. The report issued by the Livermore site, however, states merely that "records were available from 7 of these stations located 110 to 350 miles from the test detonation."

I believe that additional, if not complete, data should also have been forthcoming in view of press reports that scientists associated with the Rainier explosion developed a hypothesis that the shot would not be detected more than a few hundred, or at most, 1,000 miles away. The New York Times of September 20, 1957, reported that "in general the experiment seemed to have conformed with predictions of the Atomic Energy Commission scientists that the explosion would not be detectable more than a few hundred miles away." The Los Angeles Times reported on the same date that "scientists at more than 600 earthquake-recording stations around the globe had looked forward to the unprecedented test, hoping the blast's shock waves would race to the earth's heart to encircle it via its rocky outer crust. But the mesa sopped up the waves like a sponge and a leading quake expert said he doubts even the most sensitive instruments could have detected them 1,000 miles away."

Since the hypothesis was proved wrong as a result of the test being detected at College, Alaska, 2,300 miles away from the test site, it would seem doubly important that reports of the shot should contain a thorough account of what happened.

I realize that the various reports of these tests cannot cover the findings in every detail. But because the Atomic Energy Commission and the many institutions working with it have so much of the data on which plans for armaments control must be based, it is important that all of these agencies be especially conscious of the significance of their work in this respect. For example, many of the scientists who were responsible for conducting and reporting on the Rainier shot were members of Mr. Stassen's task force to make studies and recommendations on matters of nuclear inspection. This close association ought to mean that problems of inspection in the arms-control field are considered and dealt with in some of the Atomic Energy Commission sponsored projects.

Again let me thank you for your cooperation with the disarmament subcommittee. Although I am not a member of the Joint Atomic Energy Committee, I would be pleased to be kept informed of any work of the Commission which might affect the disarmament problem.

Sincerely,

HUBERT H. HUMPHREY.

Senator HUMPHREY. As you see, there was no desire to have a squabble, even though I must say that the Livermore report, to which we alluded yesterday, did not include the Alaska findings on the seismograph.

Mr. STRAUSS. I inquired as to that. It had not been received at the time the Livermore report was published, sir.

TIME SEQUENCE ON RELEASE OF RAINIER INFORMATION

Senator ANDERSON. Dr. York was the director of the laboratory, and on the 21st day of January he testified before us and knew all about it. When was this report of Livermore released?

Mr. STRAUSS. General Starbird says it was released in February.

Senator ANDERSON. That is right. Now you say they knew nothing about it, and here it is dated February 4, and Dr. York testified before our committee, and the minutes are available, showing he knew about it in January, and he was at that time the director of Livermore, was he not?

Mr. STRAUSS. I can only tell you what I am informed, Senator.

Senator ANDERSON. Will you tell us whether or not he was the director of Livermore in January?

Mr. STRAUSS. He was the director of the laboratory.

Senator ANDERSON. Was he still the director on February 4?

Mr. STRAUSS. I think he was.

Senator ANDERSON. I am sure he was.

Mr. STRAUSS. I do not know what time the material went to press or what the lead time there was between the submission of the material to the printer and the appearance of the document.

Senator ANDERSON. Unfortunately, this is dated February 4, and he testified before our committee in January, and General Starbird was present when he did it, that he knew about the Alaska situation.

Mr. STRAUSS. I would like to say for Dr. York, there is no more honorable man of my acquaintance.

Senator ANDERSON. I am not questioning that in the slightest.

Mr. STRAUSS. Well, there certainly is the inference that someone has deliberately deceived you, sir.

Senator ANDERSON. No, there is not, any more than you referred to the fact these people happened to release their stuff about the same time Russia was putting on a propaganda movement, a moment ago, referring to the advertisement. I am not making any inferences. I would just like to know how it happens that this material gets out and a good, honorable man like Dr. York, who testified about the Alaska episode, did not put it in here.

But let us go on.

After the copy had been prepared, it was submitted to the office in Washington by wire. What happened to it when it got to the office in Washington?

Mr. STRAUSS. Senator, I am going to turn this over to General Starbird, who is familiar with the facts. I am not.

Senator ANDERSON. We just got a question a moment ago and you said that Dr. Libby was not the spokesman for the Atomic Energy Commission, you were. And that is why my questions are directed to you.

Mr. STRAUSS. I will be the spokesman. Will you tell me the answer to the question?

REASON FOR NOT DETECTING ERROR

General STARBIRD. Yes, sir. The mistake occurred in my organization. It was a mistake not seen by the Commission until it had been made.

What happened was, the material came in to the office, my office, and one other office in Washington. It was reviewed by us there. I personally have been present at the hearing where Dr. York was testifying. I was not present at the time of the review, and my deputy signed it out.

At the time, therefore, we did not notice the error largely because I was absent at the time.

Senator ANDERSON. All right. But it got into your office in Washington; did it not?

General STARBIRD. It did, sir.

Senator ANDERSON. By wire.

Now at the same time, Mr. Chairman, it was submitted to Mr. Rodney L. Southwick, assistant manager, public information, of San Francisco. It was also submitted to Livermore. And Mr. Rodney L. Southwick read this matter, saw that they had not referred to the Alaska shot, and he telephoned to Mr. Vermillion on Friday afternoon, February 28, and told him that they had left out the Alaska shot.

Does that check with your information?

General STARBIRD. That is correct, to the best of my knowledge.

Senator ANDERSON. Since Mr. Southwick called it to their attention that there was an error, which was in favor of those who believe that you cannot detect shots, there was a possibility that somebody ought to correct it. Do you know what happened after that?

General STARBIRD. Very well, sir.

Senator ANDERSON. What did happen?

General STARBIRD. The call that came in from Mr. Southwick said that he did not know the exact reason for recommending the deletion of the two sentences concerned. The man concerned who received the call made a mental note to check further on it.

Senator ANDERSON. Mental?

General STARBIRD. Mental note, sir.

Senator ANDERSON. Only mental?

General STARBIRD. As far as I know, a mental note.

Senator ANDERSON. I will undertake at the proper time and place to bring the man in and show you it was not a mental note, but you go right ahead.

General STARBIRD. He made, to the best of my knowledge, a mental note to check into it further. He became ill and went home, and forgot it until after the release was prepared.

Senator ANDERSON. Do you know how many times Mr. Vermillion has taken sick leave in the last 5 years?

General STARBIRD. No, sir. He is an excellent man.

Senator ANDERSON. But he did get ill.

RAINIER SHOT DETECTED IN DENVER

Now, authority was received from Washington, then, on the following Monday to proceed with this information, and Washington comments were received on that Monday. Did those comments contradict in any way the fact that the Alaska information had been neglected or that they had forgotten, as they said, about Berkeley and paid no attention to Denver? Denver received these, too, 600 and some miles away, and they knew that at the time.

General STARBIRD. At the time the answer was made, the sentences concerned which had been written in had not been picked up as in error, and consequently were not changed or deleted.

Senator ANDERSON. All right.

Now, Mr. Elliott, who came in here, as I said, and was not questioned at all, took the text with him to Nevada late Tuesday, and prepared for their simultaneous release in San Francisco and here, and so forth.

Mr. Southwick, of course, had called the attention to the error. Mr. Southwick took leave of absence Monday morning, and he was gone until Friday, until after the hearing. Have you any idea why he took leave of absence, and how many times Mr. Southwick has taken leave of absence for an unexplained reason in the last few years?

General STARBIRD. No, Mr. Senator. When a man of that stature says that he took leave of absence, I do not question his motives.

Senator ANDERSON. But if it compounded the error, was it not funny that one man got sick and the next man took leave? Would you not start to inquire as to how many times he takes leave? Was he ever asked why he took leave? Do you know whether he was asked why he took leave?

General STARBIRD. I did not ask him why he took leave, sir.

DISCOVERY OF ERROR

Senator ANDERSON. When Mr. Elliott got to the point of the tunnel, where this was going to take place, do you know whether or not the newsmen were along with him when they left Mercury and went to the tunnel?

General STARBIRD. It is my understanding that they were, sir, and when they reached there or during the time that they were at Mercury, a question was raised as to whether or not the 250 miles was correct.

Senator ANDERSON. Even the newspapermen knew it wasn't correct, did they not?

General STARBIRD. The question was raised as to whether it was correct, sir, and the answer was made by the representative of Livermore who was there that he believed it was not correct; that there had been a signal shown on seismographs as far away as the Denver area.

Senator ANDERSON. Prior to his making that statement, did Mr. Elliott make the statement that he thought this referred to the point at which a sizable recording was made, and dropped the matter?

General STARBIRD. I have been told by Mr. Elliott that he made such a statement, but whether before or after, I don't know, sir.

Senator ANDERSON. Well, he made it ahead of the next statement.

Then Mr. Dale E. Nielson, of the Livermore Laboratory, spoke up, and did he tell him it was not correct?

General STARBIRD. He said, as I understand it, sir, he said to the best of his knowledge the signal had been heard in the vicinity of Denver. They discussed the mileage to Denver and concluded it was around 600 miles.

Senator ANDERSON. When they found out on the 6th the release was incorrect, did the Atomic Energy Commission do anything whatever to correct it?

General STARBIRD. The Atomic Energy Commission as such did not find out on the 6th.

Senator ANDERSON. The next day a newspaper reporter called the Geological Survey, did he not, and they told him that it had been heard in Alaska?

General STARBIRD. I believe a call came, either the next day or within the next couple of days, to our own information service, sir, asking a question.

Senator ANDERSON. I am not trying to contradict you, General. I just want to say the reason it came to your information service was that the reporter called the Geological Survey and they furnished him, without any hesitation, with the information that the shot was heard in Alaska, in Berkeley, in Denver, and so forth, and he then called the information service of the Atomic Energy Commission, if you want to put this in perspective, and said, "How come you put out the release when you knew it was heard in these various places?"

Is that not the correct chronology?

General STARBIRD. I do not know that part of the chronology. I only know what came to the Atomic Energy Commission, sir.

Senator ANDERSON. Well, I will state it as a fact that that is what happened, and if you find any evidence to the contrary, I wish you would put it in the record.

Mr. Stone called the Atomic Energy Commission at that time, after calling the Geological Survey, and was told there was no secret about it at all.

CLASSIFICATION OF MATERIAL ON DETECTION OF RAINIER

Was this regarded as classified material at any of the offices that were recording?

General STARBIRD. May I phrase the question so I fully understand it, sir. Are you asking——

Senator ANDERSON. Were there any spots where this was a classified matter?

General STARBIRD. Any spots of receipt?

Senator ANDERSON. Yes, sir, where they regarded this as classified if they heard it.

General STARBIRD. To the best of my knowledge, no, sir.

Senator ANDERSON. It was not handled in a classified fashion anywhere?

General STARBIRD. Not to the best of my knowledge, sir. I do not know of any classified handling of the results from that.

Mr. STRAUSS. The rules of the Commission would not have required it to be classified in any event.

Senator ANDERSON. I did not ask as to the rules of the Commission. I asked if it had been regarded by any of the receiving stations as a classified item.

Mr. STRAUSS. Senator, it would be necessary to ask each station whether they regarded it as classified. If they regarded it as classified, they were mistaken.

Senator ANDERSON. The information which I have given about how men got sick and men took leave, and so forth, was that fully revealed at the hearing held by the Joint Committee? It was announced that one man got sick.

General STARBIRD. I do not believe, sir, we went into the detail of saying that man was on leave when the transmission back of the revised text was made. However, I am not positive. I have not reviewed that testimony lately.

Not mentioned also is the fact that a member of the task group which conducted the test was in my office and read through the text of the release, and he did not pick up the error. The release was quite a long release, and this does not mean that any release, long or short, should not be correct. However, these two sentences did escape correction in the Atomic Energy Commission, and in the office on the west coast the man did not see the release after he had recommended a change.

Senator ANDERSON. Mr. Southwick took leave. How could he see it?

General STARBIRD. That is what I am saying, sir. He did not see it.

Senator ANDERSON. But Mr. Southwick was not the only man in the office. Mr. Southwick made this telephone call after a substantial consultation with other members of the office. It was well known in the whole office that the release was cut down to show that it wasn't possible to detect very far away, and they objected to that at Livermore.

Now, he was not the only person who knew they objected to those sentences being in there. Others did. How is the fact that he went on leave going to compel them to keep other people from speaking up and saying, "This isn't any better than it was before. It has got the same language in it."

General STARBIRD. I can't answer that question, Senator. But as far as any attempt to hide it in that office or any other office, there was no such attempt.

Mr. STRAUSS. Senator, may I make a suggestion. Let us bring these men to Washington, put them under oath, and you ask them if they had any instructions to do any of the things to which you take exception.

Senator ANDERSON. Well, I only point out that it could not have happened that this error got out unless Mr. Vermillion got sick that night, not Monday morning. He had to get sick that night, because his copy had written on it the fact that these paragraphs were wrong, and still has written on it the fact that these paragraphs were wrong. So it could not have happened unless Mr. Vermillion got sick on Friday night.

It could not have happened unless Mr. Southwick Monday morning decided to take leave. It could not have happened unless Mr.

Elliott had been confused at the tunnel. It could not have happened unless you yourself, in your own office, happened not to see the information which you had heard. It could not have happened except that nobody read the press report who knew anything about the situation.

POSSIBILITY OF EFFECTIVE DETECTION SYSTEM

And this newspaper said nobody read the press report on it in high position. And there are a lot of us who believe it is possible to detect these shots. The only shot we have had was possible of detection a long way away, and yet you steadily get the report they cannot be detected.

Now, we think it is possible, some of us do, and it is very vital, this whole question of whether or not testing can be detected. We can detect them in the air if they are only 3 kilotons. We can detect them under the ground if they are only 1.7 kilotons.

And that is why this testimony was very, very important.

Mr. STRAUSS. Senator, I do not know that anyone has testified that shots cannot be detected. I think this has only been expressed, certainly by me, as a matter of opinion, of belief.

And I would like to further add that I have a very great interest in the detection system. I instituted it myself in 1947 in order to see when the Russians would begin their tests, although, as you will recall, a great many people said it was quite beyond their capability.

I have a sort of proprietary interest in the system, and I want to see it effective and I want to see it a hundred percent successful.

But there was no purpose in deceiving you or the members of this committee or the American people into believing that it is infallible, when it is not.

Senator ANDERSON. Admiral Strauss, I have never failed to acknowledge the contribution you made in the development of the hydrogen bomb when most of the rest of the Commission stood against you and a general advisory committee stood unanimously against you.

I hope I have been completely fair.

Mr. STRAUSS. You certainly have.

Senator ANDERSON. I have never failed to acknowledge the detection system, I do not know to what scientific degree, but to a great degree, was due to your persistence you have given and to your idea about it.

But this test's very announced purpose was to measure and evaluate seismic signals at effective distances extending from the point of testing out to all distances where the signal could be detected. By your own chart here you acknowledge that the people in Alaska were alerted to be on the lookout for it, and 3 months—no, 6 months later, well, it was from September to March, nobody thought to ask them whether they had seen it, apparently.

Is that not amazing, with the development of a 2,350-mile distance area, which was one of the things you were looking for, nobody thought to ask about it?

Mr. STRAUSS. I cannot give you a satisfactory answer other than to say it was a concatenation of errors.

Senator ANDERSON. On February——

Mr. STRAUSS. I am frankly amazed that in a business of this size and complexity they are not more frequent than they are. I cannot think of one that has occurred prior to this time.

Senator SYMINGTON. Will the Senator yield for a question.

EFFECT OF CLASSIFICATION POLICIES

Mr. Chairman, getting back to some of the things we were discussing this afternoon, if we did not have such a supersecrecy lock on all these activities, against most Government activity, do you not think this thing would have broken out much quicker and not had so many facets to it as have been developed by the Senator from New Mexico today?

Mr. STRAUSS. No, Senator Symington, because the publication from the University of California Radiation Laboratory, which put this information before the technical community, is not classified. I do not know whether it is obtainable from the Government Printing Office or what the source of supply is outside of the Atomic Energy Commission, but I would venture to say that many hundreds of copies of it have reached interested technicians, and I suppose the Russians.

Senator HUMPHREY. It is rather peculiar, is it not, that that same study did not register or report the findings of seismograph stations?

Mr. STRAUSS. Can you answer that, sir?

General STARBIRD. I would like to answer it, if I might.

Senator HUMPHREY. I think this is pertinent.

SEISMIC EFFECT OF RAINIER SHOT

General STARBIRD. I think it is very pertinent. The reason is this, sir: At the time, on about February 3 and February 4, just before that, the laboratory was trying to find out a measure of the scale of the shot. We had made arrangements with the United States Coast and Geodetic Survey to make such measurements. As a result of that, I believe the date was the 3d of February—and I can furnish a copy of the letter for the record—on the 3d of February they wrote to Livermore and said, "We have good, clear records from certain stations between"—I believe the range was 100 miles and 350 miles from the detonation.

They gave certain analyses from this, and then said: "The scale of the shot, based on this, is equal to," as I remember it, "4.6 on the Richter-Gutenberg scale."

Immediately the Livermore Laboratory took that which they were after to try to measure the scale of the shock in the general region, and revised the test of the report and the seismic information that basically they were looking for, which was the nature of the shock close in so that you could determine the possibility of further and larger underground testing, was put in their report.

The report does not say that 350 miles was the limit to which signals were heard. It merely says that information from certain stations 100 to 350 miles out indicated that the scale of the shock was such-and-such.

Senator HUMPHREY. I think the point that Senator Anderson was making was that, of course, all these stations throughout the network

of the Coast and Geodetic group had been notified about this shot. In fact, it was part of the testimony that the Rainier shot could be ascertained more readily because of advance notification. I would say therefore that it is rather unusual that, after having notified so many stations, so little data was collected for purposes of publication. I do not say it was not collected.

Now to move on. No one has said, and I want the record quite clear, that you can detect every underground explosion. In fact, it is well known that one of the problems of detection and inspection is in the underground explosion area.

Furthermore, we have had very little experience in many types of detection. One of the valid reasons for the tests which are about to take place could be to provide detection information—I haven't any idea what those tests include, but if they were to include any underground tests, it surely would be helpful to gain more information on detection.

Mr. STRAUSS. We will provide that information to you, sir, in executive session.

Senator HUMPHREY. I was not seeking it particularly. I just want to mention that I would imagine the variety of tests we would be having would include tests of an underground nature.

CAPABILITY OF DETECTING UNDERGROUND EXPLOSION

The point I do think needs to be made here is that the Rainier test demonstrates that it would be rather difficult for any one station to tell the difference between an explosion and an earthquake. But it has been indicated by others that if there were a system of seismographic stations, you would greatly improve the opportunity of ascertaining an underground explosion other than an earthquake. I think this is very complicated material.

We do not need to continue the discussion, but you can misinterpret either way here. If you take only one seismographic station, you can say, "Well, there was no way to ascertain the difference between that explosion and an earthquake." But if you have a system of recording stations, by reviewing the waves and the shock record of the system of stations in the area, you would surely be much more apt to get an accurate finding of fact as to an explosion. Is that not correct?

Mr. STRAUSS. Senator, I do not know enough about seismology to be able to answer that.

Senator HUMPHREY. This is all we have heard. I know nothing about it except what we have heard.

Mr. STRAUSS. But we are convening a group of seismologists for further study, based upon the results we have had from Rainier and other results, other information we hope to have.

Senator HUMPHREY. We have sent out a questionnaire, with which I am sure you are familiar, to 37 renowned seismologists on the problem of detecting underground explosions.

Mr. STRAUSS. I think it would be a very constructive thing to do.

Senator HUMPHREY. We worked the questionnaire out with some very qualified seismologists so we can get a fairly good evaluation from the reports which may come in.

INVITATION TO OTHER NATIONS TO OBSERVE TESTS

One point that has been raised and called to my attention, Admiral, is that the President has recently invited, as I recall, the Soviet Union and others to observe the tests in the Pacific. Is that correct?

Mr. STRAUSS. It is an invitation which either has just been extended or is about to be extended by the Department of State for the Government, to the United Nations, to appoint a group—presumably the Soviets will be included, I cannot state that as a positive fact because I do not know how that Committee will be composed—to witness a shot which it is anticipated will be a shot of a weapon with greatly reduced fallout, sometime near the end of the series.

Senator HUMPHREY. I am very pleased about that. I made a recommendation about the 1st of April that such a thing be done. It is very good. It is good counteraction to some recent Soviet fleet-of-foot operations.

Admiral, back on March 7, 1956, in your testimony I asked this question:

> Now Admiral, one of your Commissioners, Mr. Murray, proposed last November that when these explosions or tests took place in the mid-Pacific, that there be a meeting at the summit again—

it is almost the same type of pattern we have now, so to speak—

> in the Pacific area where the leaders of all nations, including those of the Soviet orbit, along with other witnesses in a technical capacity, could see these demonstrations.

He thought it would aid the cause of peace for governmental leaders to see the tremendous destructive capacity of those weapons. This is practically what the President suggested in an informal manner in one of his statements.

PURPOSE OF INVITING OBSERVERS

Mr. STRAUSS. No, I think there is a fundamental difference, Mr. Chairman. Mr. Murray, as I recollect it—and you have the documentation before you—proposed that the Russians should be invited to see how destructive the weapon was. The President's proposal was that the group of U. N. nations be invited to see the extent to which we could produce a weapon from which radioactive debris had been partially or largely eliminated; in other words, to see what has been called by the press a clean shot.

Senator HUMPHREY. I do not know enough about witnessing a test—I have never seen one in my life, but I hope to, by the way.

Mr. STRAUSS. We would be very glad to have you there.

Senator HUMPHREY. To know what they can see. They could not be very close, I suppose, to the test. Whether they are going to see a clean weapon or an alleged clean weapon, they will see something.

Mr. STRAUSS. Well, the attempt will be to convince them by the methods which will be adopted that the weapon is a "clean" weapon.

Senator HUMPHREY. You were opposed to the situation in 1956, were you not?

Mr. STRAUSS. I was. The Commission was unanimously opposed to it, with the exception of Commissioner Murray, who proposed the idea.

Senator HUMPHREY. You gave your reasons. You said:

> Some of which I give here are that we had invited the Russians, and they accepted and attended a test in 1946. That is before the Atomic Energy Act was passed. There was no reciprocity.
>
> What it did was apparently to stimulate their activity. They hardly need the example of a large test, since they conduct them themselves.
>
> We have no facilities whatsoever for any housekeeping of such a group at Eniwetok or Bikini, and in the last analysis a weapons test appears the same to an observer whether it is a large one or a small one, because you have to stay farther away from the larger one.
>
> They subtend about the same angle on the horizon.

If we are going to invite them out now just to see a "clean" weapon, what is the difference in fact here? In 1956 you were opposed to their attending.

Mr. STRAUSS. I think that is a fair question.

REASON FOR CHANGING POSITION IN REGARD TO OBSERVERS

Senator HUMPHREY. Now you are for it.

I am sure there is a reason that you are for it now, and I would like to know that reason.

Mr. STRAUSS. There is indeed.

All they would have seen in 1956 was a detonation. They had them of their own.

And I do not believe that in appearance, although so far as I know no American has ever seen a Russian shot, there is any difference between an atomic explosion because it happens to be Soviet, and an atomic explosion because it happens to be our own.

The atom is fairly international.

But when we take them to Eniwetok on this occasion, we hope that they will be shown instrumentation which will satisfy them that the gross yield of the shot and the fission result of the shot are figures X and Y, and that the difference between them is a very great difference.

Senator HUMPHREY. I see.

Senator SYMINGTON. Mr. Chairman, will you yield?

Am I to gather they are going to see the progress we have made in developing a clean bomb?

Mr. STRAUSS. Without being told how it is done.

In other words, the law provides that the design and construction and composition of a weapon is restricted and that they will not see it.

VALUE OF INSPECTION SYSTEM

Senator SYMINGTON. Mr. Chairman, just sitting here this afternoon and listening to this discussion, this idea runs through my mind: We talk so much about whether we can detect or whether we cannot detect and it would seem to me that one of the greatest things we can do from the standpoint of the future is to get some Americans on a formal basis into the Soviet Union and if another chance comes up whereby we may do that so long as it does not commit us, would you be for it?

Mr. STRAUSS. I understand, Senator Symington, that considerable numbers of Americans go there regularly as tourists and as exchange professors and one thing or another and the reverse occurs. I do not

know whether we have had Russian tourists but we have had very considerable numbers of technical groups that come over.

Yes, as long as it is the policy of those who conduct the foreign affairs of this Government irrespective of party, I am for it.

Senator SYMINGTON. Well, I may say respectfully, I do not think your answer is entirely responsive to my thought.

Mr. STRAUSS. I am sorry. My attention has just been called to that by General Starbird.

Senator SYMINGTON. But I am so glad you answered it that way because we get maybe a little distorted idea about Russia when we go over there because I think we will both agree—we see exactly what they want us to see—and do not see anything they do not want us to see.

If you have any doubts of that, I suggest you talk to the Chairman of the Joint Chiefs who was over there less than 2 years ago.

Mr. STRAUSS. I have talked to some Members of the Senate who visited Russia and I got the impression they saw what they were intended to see.

Senator SYMINGTON. But not what they would like to see.

Mr. STRAUSS. Some of them did not see what they would like to see.

Senator SYMINGTON. Now my point is if we accept, for example, their suggestion that we discuss nuclear cessation and then you automatically get into the question of locations of inspection teams, and for the first time it seemed to me going over all of the data, listening to the talks made by Senator Humphrey and so forth, it seems to me we would have had a chance to maybe for the very first time see some things that perhaps they did not want us to see.

In other words, there would not be any sense in proceeding if they refused to allow us to go to places which might be considered inspection places. In other words, we would be more formal than a visitor, whether it was a tourist or a Senator. A Senator can be a tourist and that is all he is in Russia.

HELPFULNESS OF DISCUSSING INSPECTION SYSTEM

Here was a chance for the first time on a Government basis to have a good many Americans go into the Soviet Union, and go around and see some things they wanted to see or else the whole situation would automatically be absurd.

If we get a chance like that again don't you think we ought to take it?

Mr. STRAUSS. It depends on the price you pay for it.

Senator SYMINGTON. Well, by this time was there any price that we knew?

Mr. STRAUSS. I thought you meant—I am sorry. I thought you meant cessation of testing was to be a part of this.

Senator SYMINGTON. Well, we would go over there to discuss that, and you could not discuss the cessation of testing as a practical plan unless you let them look over our places as to where they would want to put inspection teams, and in turn we would have the right to look over theirs; otherwise the matter would all break down. But it was their idea; and, as I have said before, I think we made a mistake, an honest mistake, but in my opinion, a bad mistake; and it was the first time since the end of the war, that we might have gotten a lot of

Americans into Russia on a formal basis where they had the same rights in that country that we, because we play it square, would give their people who were here, and we would be discussing disarmament incident to world peace.

We threw that overboard and I would hope the next time we do not surround it with a lot of things to the point where they reject it right away and then we are back where we were when we started.

That is the thought that keeps running through my mind as I listen to all these technical details about detection and nondetection.

It seems to me that is the big thing to talk about.

Won't you agree?

Mr. STRAUSS. I do and I hope for some further opportunity to discuss it with you.

Senator SYMINGTON. Thank you, Mr. Chairman.

REASON FOR FAVORING DISARMAMENT PACKAGE AGREEMENT

Senator HUMPHREY. Admiral Strauss, I just want to ask this one question: What factors are there in your mind, in light of your feeling of the injurious effect of the cessation of tests, which make it desirable for us to enter into an agreement?

You have said you felt that a cessation of tests, even with inspection, would injure us technologically and from a defensive purpose.

Mr. STRAUSS. Yes.

Senator HUMPHREY. You agree with me the stockpiling inspection is difficult?

I think you agree it is difficult but surely not impossible on the cutoff of production of nuclear materials for weapons purposes.

Mr. STRAUSS. Certainly not impossible.

Senator HUMPHREY. Yes. But now when you add those three up it does not come out to really a big plus in terms of your ultimate conclusion.

What I want to know is what other factors are there that make it desirable for us to have agreement that you seem to be willing to support even though you are opposed to at least one of the sections of the agreement and doubtful as to another one.

Mr. STRAUSS. I am opposed only to the section of the agreement, standing by itself which would disadvantage the United States as I see it.

And there are not other considerations in my mind than those I have mentioned for the whole package and the primary consideration there is nuclear disarmament.

If we can get nuclear disarmanent, the threat of the kind of war which now hangs over the world, would be removed.

I do not expect that it can be achieved except for over a long period of time.

Senator HUMPHREY. Some of our military people believe that if we had genuine nuclear disarmament, it would require a substantial change in our military posture in light of the tremendous manpower resources of the Soviet and their modern conventional arms, if we were to have any kind of defensive capabilty that was worthy of the name.

Now you are advocating nuclear disarmament before we get a stop on the cessation of tests?

DANGER OF NUCLEAR WAR

Mr. STRAUSS. I might add, Senator, that nuclear war is the only war that has ever threatened the United States.

Senator HUMPHREY. What about our allies to whom we are committed?

Mr. STRAUSS. We have commitments to our allies and can protect them.

Senator HUMPHREY. Rather serious ones.

Mr. STRAUSS. And can protect them, but the only thing that has threatened the whole world and the existence of life on the planet is nuclear war.

I am not terribly sanguine that any of these things will come to pass but I think as men of good will we must attempt to bring them to pass.

Senator SYMINGTON. Mr. Chairman, surely we cannot take a syllogistic premise and say that because we cannot be hurt by conventional war even though our allies can be destroyed very rapidly by conventional war, that we should not be at least as interested in conventional war as we are in nuclear war.

Mr. STRAUSS. I did not say that. I do not believe that we should submit——

Senator SYMINGTON. I thought you said the only war that could hurt the United States was nuclear war.

The implication is that that too is a $50 billion bust?

Mr. STRAUSS. No.

Senator SYMINGTON. That is right.

Mr. STRAUSS. No. I do not think so.

Senator SYMINGTON. I think any war against the free world and our allies is war against the United States.

Mr. STRAUSS. I am sorry. I did not mean that war could not be conducted against the United States. War has been conducted against the United States by conventional weapons. But the only kind—the introduction into the world of nuclear weapons and the possession of large amounts of nuclear weapons by a hostile nation endangers the United States in a way that it has never been imperiled for the first time in its history.

I think you would agree with that.

CONCLUDING COMMENTS

Senator HUMPHREY. Any other questions?

Mr. STRAUSS. Senator, I want to thank you for permitting me to appear. I feel benefited from this session. I doubt whether I have given—have cast any light on your problems.

Senator HUMPHREY. You have indeed. You have been very cooperative. We are very grateful to you and may I say to the members of your staff. I want to say publicly that we have had very fine cooperation from the members of your staff that have come before us.

I shall not go into the different names because I may leave someone out but they are here in this room. Whenever we have asked them for information we have been able to obtain it and we are grateful to you.

Mr. STRAUSS. We will continue to be at your service.
Senator HUMPHREY. We want you to know we appreciate it.
Mr. STRAUSS. Thank you, Mr. Chairman.

KNOWLEDGE OF SOVIET POSSESSION OF ATOMIC BOMB

Senator HICKENLOOPER. Mr. Chairman, I do have one thing I would like to insert in the record here because it is historical and I think it should be renewed from time to time just to keep ourselves in perspective.

On January 27, 1953, former President Truman made a statement, and this is January 27, 1953. In that statement he is quoted as saying by the newspapers:

I am not convinced that Russia has the bomb—

meaning the atomic bomb—

I am not convinced the Russians have achieved the know-how to put the complicated mechanism together to make an A-bomb work. I am not convinced they have the bomb.

This was a statement made in 1953—January 27.

In response to that statement, Representative Carl Durham of North Carolina who was then the retiring chairman of the Joint Committee on Atomic Energy, Representative Sterling Cole, who was at that time in January the ranking majority member on the committee, from the House side, and myself, as the ranking Senate majority member of that committee, issued a statement in response to that statement.

I would not put this statement in the record except that it is a nonpartisan statement or a bipartisan or whatever one wants to call it, because Representative Durham is a Democrat and Mr. Cole and I were Republicans.

In this statement which I shall not read at this time in full, a review of the activities on detection occurred in this field.

This is significant because we joined, having some knowledge of the historical background of the efforts toward detection and familiarity with detection, which our committee had insisted upon—I want to read one paragraph and ask permission to put the whole release into the record at this point.

It refers to Chairman Strauss.

Senator HUMPHREY. That may be done.

(The document in its entirety is as follows:)

JOINT COMMITTEE ON ATOMIC ENERGY,
January 27, 1953.

STATEMENT OF REPRESENTATIVE CARL DURHAM (D., N. C.), RETIRING CHAIRMAN, SENATOR BOURKE B. HICKENLOOPER (R., IOWA), RANKING SENATE MAJORITY MEMBER, AND REPRESENTATIVE W. STERLING COLE (R., N. Y.), RANKING HOUSE MAJORITY MEMBER

Today former President Truman is quoted as saying, "I am not convinced Russia has the [atomic] bomb. * * * I am not convinced the Russians have achieved the know-how to put the complicated mechanism together to make an A-bomb work, I am not convinced they have the bomb."

The purpose of this joint statement is to clarify history and to point out that the ex-President's statement is highly unfortunate in that it contradicts indisputable evidence not only available today but available in 1949.

A report of the Joint Committee on Atomic Energy, dated October 19, 1951, stated as follows:

"In the first months of its existence the committee took two steps: (1) It pressed for a strong United States intelligence effort directed at the atomic energy activities of potential enemies; and (2) it brought unrelenting pressure in behalf of all endeavors to secure information which would enable the United States to know when any atomic test explosion took place on the continents of Eurasia. The intensity of the committee's interest as to both phases has continued at peak level throughout. The active intervention of a handful of individuals, some of whom are committee members, may well have meant the difference between failure and success in becoming aware of the * * * Soviet bomb tests announced by the President. Had these * * * tests passed unnoticed in the United States, the consequences to ourselves could have verged upon the disastrous."

One individual is largely responsible for successful United States detection of the three Soviet atomic bomb test explosions thus far announced from the White House. This individual is former AEC Commissioner Lewis L. Strauss. Mr. Strauss found that inadequate measures were being taken to inform the United States about any unsuccessful Russian weapon test. He, therefore, went to Mr. Forrestal and Mr. Patterson and other high-ranking military and civilian officials and insisted that the necessary measures be undertaken. In this effort he had the powerful backing of Senator Hickenlooper, then Chairman of the Joint Committee on Atomic Energy; Representative Cole, ranking majority member on the House side; and Senator McMahon and Representative Durham, ranking minority members. It was Mr. Strauss' foresight, relentlessly endorsed by the Joint Committee—and assisted on the technical side by Dr. Lawrence R. Hafstad, now director of AEC Reactor Development—that brought into being many of the vital measures which averted the disaster that might have ensued had the United States remained ignorant of Russia's success in achieving the atomic weapon.

In 1949 there began to arrive intelligence data indicating that Russia had tested her first bomb. This intelligence data—like any other similar material—had to be carefully evaluated. Even in the early phases of evaluation, however, it was clear that in all probability the Soviet explosion had been a weapon test and not an accident. Nevertheless, for a few days, it was possible to entertain narrow hopes that the explosion was not an actual test.

During this period of a few days 1 or 2 high officials in the executive branch vehemently took the position that the Soviet explosion could not have been a bomb test and that it might have been due to accident. Within a very short time thereafter—before September 23, 1949—the evidence had been fully evaluated and it simply did not admit of doubt.

A special board of the Nation's foremost experts was called in to review the evaluation. The board members—and there are no more technically qualified individuals to be found in the United States—were completely convinced that the Soviets had tested a weapon device and so reported on September 23, 1949, to the Joint Committee on Atomic Energy.

The evidence was again reviewed during fall 1949 in the interest of supercaution, and once again the evidence was found by the most competent technical authorities to show conclusively that the Soviets had indeed tested a bomb. Probably never in the history of intelligence has such clearcut evidence been examined so exhaustively so often to arrive at the same simple and unavoidable conclusion.

This whole episode has an ironical aspect in that the executive branch, with the backing of President Truman, determined before September 23, 1949, not to disclose the nature of the evidence to the Joint Committee—a decision violating the Atomic Energy Act which requires the Joint Committee to be informed. We term this decision ironical not only because the Joint Committee already knew the measures being taken but had been itself highly instrumental in causing those measures to be adopted in the first place. Soon after September 23, 1949, the Joint Committee did gain access to all details about the first Soviet bomb test.

On October 3, 1951, Mr. Truman, as President, himself publicly stated—and we quote—"Another atomic bomb has recently been exploded within the Soviet Union." On October 22, 1951, the White House announced that a third atomic bomb explosion had occurred in Russia. It is interesting to note that yesterday the ex-President referred in his statement to only two Soviet tests, whereas he himself—when President—announced three such tests.

Senator HICKENLOOPER. I say this with some knowledge of the background. We said in this nonpolitical document:

> One individual is largely responsible for successful United States detection of the three Soviet atomic bomb test explosions thus far announced from the White House. This individual is former AEC Commissioner Lewis L. Strauss.

Chairman Strauss was not at that time on the Atomic Energy Commission in January 1953.

> Mr. Strauss found that inadequate measures were being taken to inform the United States about any successful Russian weapon test. He, therefore, went to Mr. Forrestal and Mr. Patterson and other high-ranking military and civilian officials and insisted that the necessary measures be undertaken.
>
> In this effort he had the powerful backing of Senator Hickenlooper, then chairman of the Joint Committee on Atomic Energy; Representative Cole, ranking majority member on the House side; and Senator McMahon and Representative Durham, ranking minority members.
>
> It was Mr. Strauss' foresight, relentlessly endorsed by the Joint Committee—and assisted on the technical side by Dr. Lawrence R. Hafstad, now director of Atomic Energy Commission reactor development—that brought into being many of the vital measures which averted the disaster that might have ensued had the United States remained ignorant of Russia's success in achieving the atomic weapon.

Now as I say this statement was made, occasioned by former President Truman's statement on January 27, 1953, that he did not believe Russia had had the atomic bomb and after three announcements had been made from the White House itself during the period while he was President, and this is a matter of historic record, and I would ask that it be included in the record.

Senator HUMPHREY. It shall be included.

OBJECTIVES OF SUBCOMMITTEE

As we conclude this part of the testimony, I think it is only proper to state that this is not a committee that has as its object to seek all possible ways and means of building an enduring peace even though this is the desire of every member of this committee.

As I said before, we look upon the discussions in disarmament as only one of the steps toward the long road to a peace worthy of mankind.

I have felt that if we could once make an entrance on the road to peace through some initial step in disarmament, we might find ways and means of talking out other problems. Along with the statement of my colleague and associate here, Senator Symington, it has been my view that the inspection agreement itself was the great political breakthrough that was needed. I believe that this has merits within itself that may even outweigh any technical asset or liability on the matter of cessation of tests.

That is just a personal expression and we have had very valuable evidence about the adequacy and the efficacy of detection.

We think that progress is being made and I am sure that you, sir, would agree with me that considerable progress has been made.

Mr. STRAUSS. Yes, sir, and I think more will be.

Senator HUMPHREY. It is important that every possible emphasis be placed upon making this progress. I believe that is all.

We have with us again Dr. Teller, who testified yesterday.

We wanted Dr. Teller to come back because we had some matters we wanted to discuss in executive session. I believe you are leaving Washington soon, aren't you, Doctor?

Dr. TELLER. I had planned on leaving tonight.

Senator HUMPHREY. That is right. I was hoping we might have time for some more testimony in public session but I am afraid we have not. We are going to ask you to stay just a little while for an executive session. It will necessitate a brief recess so we can clear the room.

(Whereupon, at 4:35 p. m., the committee was recessed, to convene in executive session.)

APPENDIX I

UNIVERSITY OF CALIFORNIA, *April 25, 1958.*

Hon. HUBERT H. HUMPHREY,
United States Senate,
Washington, D. C.

MY DEAR SENATOR HUMPHREY: In accordance with your request I am sending you my remarks on Dr. Orear's testimony.

First I shall make some short and general comments on Dr. Orear's testimony, which will be limited to the most essential points. Then I will quote some statements from the testimony and discuss them individually. I shall discuss only questions which are connected with technical points.

GENERAL COMMENTS

Dr. Orear greatly overestimates the accuracy with which the position of an earthquake can be fixed. He believes that the effects of an earthquake on the surface structure can be readily distinguished from the effects of a deep underground explosion. This definitely is not so. Dr. Orear furthermore believes that the seismic records of the earthquakes differ in an obvious manner from the records of nuclear explosions so that hardly any inspection is necessary. In this point again Dr. Orear is much too optimistic.

Probably the most flagrant misstatement in Dr. Orear's testimony is his assertion that a nuclear explosion of less than a kiloton is of no military value. He says, "We all agree that nuclear explosions can be made so small as to be undetectable. But such devices would not make practical weapons." This statement shows complete ignorance on his part of our military situation and is hardly consistent with commonsense. Dr. Orear also guesses that a kiloton explosion and a megaton explosion can be produced by weapons of similar weight. His statements merely prove that he is not informed about the topic. Indeed, as he himself says, he has not worked on nuclear weapons and had no contact with the subject. It should be emphasized that Dr. Orear's professional standing as a physicist does not give him any authority concerning the construction or use of weapons.

SPECIFIC COMMENTS ON STATEMENTS FROM DR. OREAR'S TESTIMONY

Page 1503

"The Soviet Union has about 75 high-quality stations and would probably be willing to send copies of these records. * * * It would be a great risk to attempt any alteration of these records because they must be self-consistent and also check with the records of the neighboring free countries such as Japan and India."

Comment

Reliance on the Russian seismic stations would certainly give us insufficient information. The greatest difficulty in distinguishing an explosion from an earthquake is due to the "noise" in the instrument. Such noise is due to various causes ranging from the passage of a heavy truck to the pounding of ocean waves on the distant shores of the continent. These small causes bring about changes in the record which obliterate the fine details necessary to notice the characteristic behavior of an explosion. It would be most easy for the Russians to make sure that the most strategically located seismograph should happen to be some-

what disturbed at the time of the explosion. Such disturbances are so frequent that there would be no reason to be suspicious.

Page 1504

"I believe the small bombs referred to by the previous witness are so small that they would be smaller—they are certainly smaller than anything anybody has ever used as a nuclear bomb so far. To me it is questionable whether you are going to use nuclear explosives for a hand grenade."

Page 1508

"I am certainly not a military expert, but my feeling is that if you get to bombs in an order of magnitude below this kiloton region, you are already in a region of World War II chemical bombs, and I would tend to doubt that you are going to use nuclear explosives for those."

Page 1508

"I do know that you can deliberately make a nuclear explosion as small as you want by making it inefficient, but in that case my feeling is you might as well be using chemical explosives."

Comment

In these statements Dr. Orear ignores the important fact that it is much easier to make a light nuclear weapon available in combat than to deliver 10 tons or 100 tons of conventional high explosives. For instance, the light nuclear bombs can be much more easily delivered by air or else they can be transported by air so as to make them available to our ground forces. The importance of some ways in which small weapons can be used in combat has been brought out by excellent statements of General Gavin.

Page 1504

"* * * I am talking about hundreds of monitoring stations, because we are making use of all of the existing stations that are all over the world * * *."

Comment

Stations that are farther removed from the explosion than a few hundred miles appear to be useless in distinguishing between small explosions and earthquakes.

Page 1505

"If Russia did not try to cheat, then the type of records I am thinking of would be of such a nature that the U. N. inspection agency would perhaps never get a strong indication of what looked like a secret explosion."

Page 1507

"* * * our feeling is that if Russia did not cheat on the tests, that we probably never would get a signal strong enough for us to ask permission—for us to claim, 'Look, this looks like it was a secret bomb. We want to go in and investigate.'

"The smaller earthquakes, say the magnitude four, you probably have to ignore completely, don't even bother looking at those records * * *."

Page 1508

"My feeling right now is that this would be a quite workable system, and it would be very rarely that we would ask permission to investigate a site, or rather very rarely that we would get an indication of a violation. Probably if we had an indication of a violation, it really was a violation. In that case, Russia would not let us into the site anyway."

Comment

Even if one puts a considerable number of sensitive seismographic stations there will be a very great number of earthquakes that one will not be able to distinguish from kiloton explosions. This is certainly true as long as one confines oneself to detection methods known at the present time. There might be further developments in detection methods. On the other hand I believe that we shall even more rapidly learn how to set off underground explosions whose effects look like small earthquakes.

Page 1505

Dr. Orear has correctly explained that a nuclear explosion is generally characterized on the seismic records by the fact that the first motion in the

seismogram is in a direction away from the explosion. He then proceeds to discuss the records obtained from the Ranier shot:

"Now looking at these records, there aren't too many of them, the ones that are listed, there are eight stations we definitely received the direction of first motion. * * * The farthest such station was 520 miles away at Pinedale, Wyo."

Comment

This statement by Dr. Orear is literally correct but at the same time it is misleading. His statement is apparently taken from a report by the United States Department of Commerce Coast and Geodetic Survey, dated March 13, 1958. According to this report there are seven stations located at a distance not greater than 230 miles which received signals in which the motion was in the direction away from the explosion. Within the same area 2 stations had no clear indication what the direction of the first motion was and in 4 additional stations the data were not yet evaluated as of March 13, 1958. In 14 stations ranging from 230 miles to 460 miles no clear indication of the first motion was seen (in one of these stations the data had not yet been evaluated). In one station, namely, in Pinedale, Wyo., at a distance of 520 miles the motion was in the direction away from the explosion. There appear in the list a considerable number of stations at greater distance at none of which is there an indication of the first motion. The evaluation therefore essentially depends on the seven stations which are really quite close (230 miles or less). That there is good evidence of an explosion is due to the proximity of the Nevada site to the dense net of seismic stations located in California and vicinity. A net in Russia as proposed by Dr. Orear could cover the territory only if the stations would be spaced at distance of 500 miles or more. Such a net of stations would have given quite insufficient data about the Nevada event and we would not have obtained good evidence that an explosion rather than an earthquake has occurred.

Page 1505

" * * * we know we can pinpoint the location to within about 1 mile * * *."

Comment

According to my understanding this is a very great exaggeration of accuracy.

Page 1505

"It would be just a simple problem of observation by a geologist to tell that here was an underground explosion and not an earthquake.

Page 1511

"Suppose we tried to camouflage the site at Test Rainer? I think for a trained geologist this would be an impossibility, that we could not camouflage it. If a mountain moved up in the air 6 inches, I don't see how you can camouflage the effect."

Comment

The mountain, of course, settled right back. The explosion was set off below a mesa. The only really noticeable change was the fact that some rocks rolled down the steep face of the mesa. This could be easily avoided by positioning the explosion at a point distant from any steep inclines. On the flat part of the mesa there was no observable effect beyond some fissures of a small fraction of an inch. This would not have been noticed by anybody who had not inspected the site before the explosion. Furthermore the explosion was at the relatively shallow depth of 900 feet. It would have been easy to set off the explosion at a greater depth in which case probably no visible effect would have resulted. Orear's statement that the local effects give a clear indication to a geologist is certainly incorrect.

Pages 1505–1506

Dr. Orear proposes to ignore all earthquakes that are of a magnitude less than 5.

Comment

Assuming that the explosion is carried out in a way similar to our Ranier shot, an earthquake of magnitude 5 would correspond to a nuclear explosion of considerable yield. According to which theory of earthquakes you adopt, a magnitude 5 earthquake will correspond to an explosion between 6 kilotons and 35 kilotons. If Dr. Orear's suggestion is accepted explosions that are smaller

than 6 kilotons will surely go unidentified and explosions as big as 35 kilotons may go unidentified. If one makes further progress in hiding explosions then even bigger explosions might escape identification.

Pages 1506 and 1507

Dr. Orear says that there are in Russia 100 earthquakes per year of magnitude 4.6 or greater and that there are 120 earthquakes of magnitude 4.25 or greater.

Comment

Both of these figures are quite inaccurate. I cannot quote the actual figures because I have seen them only in classified testimony. However, I can make a statement of what the ratio of these two figures should be. According to statistics on earthquakes all over the world, there are approximately twice as many earthquakes of magnitude 4.25 than there are earthquakes of magnitude 4.6. Orear estimates that the difference is only 20 percent. The two figures are therefore inconsistent with general information about earthquakes.

Page 1508

"But I think we should keep in mind if Russia does object to such an unlimited mobility of the inspectors, that this should not rule out all possibilities for a test ban agreement. If we have reservations about the uncertainties involved in underground detection, and the possibility that a very low yield test may escape positive identification, this first-step agreement ban only those tests which are detectable."

Comment

This statement is unclear because it does not specify in which way detection will be accomplished. In any case there will remain a gray region where positive identification is impossible but suspicion may have been aroused. Anyone who is willing to indulge in deceit will be at a great advantage. In the United States such deceit cannot and should not be possible.

Pages 1510 and 1511

"If I were shooting down an airplane, I would use a clean H-bomb in the megaton region. This only takes about 40 pounds of deuterium."

"I would like to point out that a 1-kiloton nuclear weapon would probably be the same size and weight as far as the external size of the bomb or missile goes as the 1-megaton nuclear weapon, and they would both be of comparable radioactivity, so I would use a 1-megaton weapon to shoot down a plane, because then I don't have to hit it."

Comment

Dr. Orear considers only the weight of the deuterium. He appears to be ignorant of the methods and the mechanical requirements which are necessary to start a thermonuclear reaction in deuterium. He also ignores the fact that if one shoots down a relatively low-flying plane by a megaton weapon one may cause unnecessary and great damage to one's own country which can be avoided when much smaller weapons are used. He also seems to be under the misapprehension that a 1-kiloton weapon must hit a plane in order to shoot it down.

Page 1513

"I would tend to think it is a difficult technical problem to build a first bomb which will definitely turn out to be below 1 kiloton. If you assigned me this problem, I might not be able to solve it for sure."

Comment

Among all problems connected with nuclear weapons the one Dr. Orear mentions here is perhaps the easiest.

Page 1517

"* * * in the palm of my hand I can hold enough plutonium to be a 1-megaton bomb, so it is very mobile, it can be hidden away, as I said, using the suitcase method of delivery."

Comment

The weight of plutonium to give a megaton weapon is 110 pounds. This in itself is heavier than the expression used by Orear suggests. The weight of 110 pounds, however, is valid only if all the energy in plutonium is liberated. Furthermore Dr. Orear ignores the weight of the mechanism needed to convert 110 pounds into an effective bomb.

Page 1519

Dr. Orear discusses the radioactivity produced by the neutrons escaping from a clean thermonuclear explosion.

Comment

In essence Dr. Orear's statement is correct. In some applications of nuclear bombs radioactivity will necessarily be produced by activating nearby materials. Even so, this radioactivity will be far less dangerous than the activity that would have been produced by a fission bomb of the same explosive power. In peacetime applications one can surround the explosive by materials which harmlessly absorb neutrons. Among these a boron solution may be the most effective. By this method the activity may be reduced to a completely safe amount.

Page 1520

"If you attack the missile above the earth's atmosphere, in the stratosphere, then this radioactivity takes on the average of 10 years to fall down and falls down all over the entire earth, so any individual person who gets it, gets quite a small amount."

Comment

This answer of Dr. Orear explicitly ignores the possible danger from worldwide fallout. This danger actually is quite insignificant as long as nuclear tests are considered. However, the danger will become very serious indeed if great numbers of dirty nuclear weapons are used for high-altitude defense in a war. One should particularly bear in mind that a single nuclear explosion may not destroy an attacking enemy missile. Therefore the number of nuclear explosions needed in defense will probably have to exceed the number of nuclear bombs which the attacker is using.

I have not quoted all of the statements of Dr. Orear with which I find myself in disagreement. I tried to concentrate on those where a particular technical point had to be made.

Sincerely yours,

EDWARD TELLER.

APPENDIX II

COLUMBIA UNIVERSITY IN THE CITY OF NEW YORK,
DEPARTMENT OF PHYSICS,
April 28, 1958.

Hon. HUBERT H. HUMPHREY,
Senate Office Building,
Washington, D. C.

DEAR SENATOR HUMPHREY: I have just received from Dr. Edward Teller a copy of his remarks on my testimony of April 16. Thanks to the work of your committee and Dr. Teller's cooperation, it is now possible to resolve some of the technical inconsistencies that you have been receiving.

I would like to make a few comments on Dr. Teller's remarks which I hope will help resolve some of these inconsistencies. Dr. Teller questions two general areas of my testimony: (1) my "optimism" about seismic detection, and (2) my remarks about small nuclear weapons.

1. SEISMIC DETECTION

First, I would like to explain in a little more detail this plan of using the existing 75 Soviet seismic stations. Just as in the United States, these stations are concentrated in the seismic belts which are of small area compared to the entire Soviet Union. Thus there would be many stations within a few hundred miles of each earthquake. If you wish, Dr. Jack Oliver of the Columbia Lamont Geological Observatory, Palisades, N. Y., can send you a map showing the locations of these stations. Dr. Teller says "the Russians could make sure that the most strategically located seismograph should happen to be somewhat disturbed at the time of the explosion." However, they would not dare disturb all of the nearby seismographs. That would be a giveaway.

Dr. Teller says, "Dr. Orear proposes to ignore all earthquakes that are of a magnitude less than 5." In my testimony I said, "The smaller earthquakes, say the magnitude 4, you probably have to ignore completely." Actually if I was only using the direction of first motion of the Soviet records, I would only consider

those shocks which give more than 5 or 6 directions of first motion. This criterion would have detected Test Rainier and would also probably never make the mistake of including an earthquake as a possible explosion. Offhand, neither Dr. Oliver nor I know of an earthquake which gives 7 directions of first motion away from the source and none toward the source.

Contrary to the opinion of Dr. Teller, American earthquakes—and especially explosions—have been located more accurately than 1 mile using existing seismic stations. Concerning the problem of finding the exact location, I said it would be simple for a geologist to locate Test Rainier just by observing the surface disturbance. If the secret-underground test had been so deep that there was no local ground disturbance, it could still be pinpointed in location and depth by geologists using small explosives and seismic reflections as is done in oil prospecting.

Dr. Teller says "there should be twice as many earthquakes of magnitude 4.25 than there are earthquakes of magnitude 4.6. Orear estimates that the difference is only 20 percent." I believe both my testimony and the report I submitted at the time estimate 120 earthquakes greater than magnitude 4.25 and 60 greater than 4.6 for the number of earthquakes per year in the land areas of the U. S. S. R. Dr. Teller says, "Both of these figures are quite inaccurate. I cannot quote the actual figures because I have seen them only in classified testimony." I suspect that these "classified people" were counting underwater and Mongolian earthquakes. There is absolutely no reason why such testimony should be classified. Certainly the Russians know more about their own earthquakes than we do. I feel your committee may have been misled by this classified testimony, and I hope that it will soon be declassified so that we can get these numbers straightened out. Upon the request of your committee, I have just submitted a detailed study of the frequency of earthquakes in the U. S. S. R. based on the extensive world listings of B. Gutenberg and C. F. Richter in their book Seismicity of the Earth. Also Dr. Jack Oliver using a very recent Russian paper on the seismicity of the U. S. S. R. in the year 1955 estimates about 120 U. S. S. R. earthquakes per year greater than magnitude 4.25. Our two independent methods of approach give closer agreement than would normally be expected. Dr. Oliver has just mailed his findings to your committee.

2. SMALL NUCLEAR WEAPONS

Finally I would like to discuss the subject of small nuclear weapons. First I wish to say that I regret writing in my prepared statement, "We all agree that nuclear weapons can be made so small as to be undetectable. But such devices would not make practical weapons." I prepared this statement hurriedly with just a few hours' notice. I should have written it as I later said it in my testimony, "They (such devices) are certainly smaller than anything anybody has ever used as a nuclear bomb so far." I would like to emphasize that, as I said in my testimony, "I am certainly not a military expert" and that my answers to such questions must be those of a layman. After thinking over the questions of Senator Symington, it is conceivable to me that it may be practical for nuclear weapons to overlap some conventional chemical weapons.

In my comparison of size and weight of a 1-kiloton to a 1-megaton weapon, my feeling is that they are the same within an order of magnitude. However, I have no classified knowledge on nuclear weapons and am not an expert. But I am sure a 1-megaton bomb is not 1,000 times bigger in size than a 1-kiloton bomb. However, a 1-megaton antiaircraft weapon is 1,000 times as effective as a 1-kiloton weapon (the volume of comparable blast effect is proportional to the yield of the bomb).

I did not intend to exaggerate when I said, "In the palm of my hand I can hold enough plutonium to be a one megaton bomb." I actually have held about 50 pounds of U–238 in the palm of my hand. My hand is 7 inches long and can hold a 5½-inch cube of uranium or plutonium. Of course it would weigh 110 pounds, but I could still barely hold it. Dr. Teller says, "Dr. Orear ignores the weight of the mechanism needed to convert 110 pounds into an effective bomb." But I did explain in my testimony that smuggling using suitcases might be impractical. I proposed smuggling by ship. Many times I explained that our group uses the suitcase delivery system as a figure of speech.

If you feel it will help resolve the differences confronting your committee, I would welcome Dr. Teller's comments on these additional remarks of mine. Also

if you so desire, I could make point-by-point comments on Dr. Teller's testimony as he has done on mine.

Sincerely yours,

JAY OREAR.

Hon. HUBERT H. HUMPHREY,
Senate Office Building, Washington, D. C.

DEAR SENATOR HUMPHREY: Enclosed are a few of the many comments I have on parts of Dr. Edward Teller's testimony of April 16. I appreciate the interest of the Senate Subcommittee on Disarmament in my comments and I hope these comments will help resolve some of the inconsistencies facing your committee.

SPECIFIC COMMENTS ON STATEMENTS FROM DR. TELLER'S TESTIMONY

Page 1457

"What a nuclear explosion underground will do, we know from one and only one shot, and a small shot at that.

"If we had not performed this one shot, we would compare the known facts about earthquakes with a complete vacuum of knowledge."

Comment

There have been thousands of underground explosions which have been studied. Several of these have been of greater energy release than Test Rainier.

Page 1457

"If thereupon we do not continue to test, but the Russians experiment with small nuclear explosions which we know can be hidden, then by their experimentation, they may find out a great deal. I think they will find out more and more and clearer and clearer methods how to make these explosions disappear among the many earthquakes which occur spontaneously."

Comment

It should be pointed out that for each small explosion there is some probability of detection. Such a program of a large number of evasions runs a serious risk of eventual detection.

Page 1458

"I know that radioactivity which we have released is quite small compared to the natural background with which we are familiar and about which we never have been worried."

Comment

But the natural background is a serious hazard. Even more serious is the possibility that the present policy is leading us to eventual nuclear devastation. For this reason, I and many other scientists tend to ignore the fallout hazard. However, recently I was asked to write a review of the book Our Nuclear Future, by Teller and Latter, which deals at length with the fallout hazard. The following excerpt from my book review (for the June Bulletin of the Atomic Scientists) explains the seriousness of the natural background and fallout: "The usual way of minimizing the effects of fallout is to compare it to X-rays, wristwatches, and natural radiation without pointing out the serious loss of life caused by the natural radiation. The natural mutation rate is estimated to be 1 gene per 3 births. Serious visible abnormalities occur to 1 birth to 50. The exact percentage of mutations due to the natural radiation is not known. Teller and Latter estimate 10 percent.

"It would seem to me more fair to compare fallout with something which is more familiar and generally recognized as a serious hazard—such as all-out war. If Teller and Latter had done this they would have found that the loss of American life due to the past tests is about twice that of the Korean war and 40 percent greater than the amount of American life lost in battle in World War I (this is using the estimates given by Teller and Latter)."

Page 1460

"Stockpiles can be so easily hidden that I believe that this is really practically impossible.

Comment

The Columbia inspection study has come up with a powerful inspection technique which is applicable to the stockpile problem and would make it very risky for a country to attempt to hide part of its stockpile. We call this new inspection technique "inspection by the people." The technical details are presented in our final report, Inspection for Disarmament, to be published.

Page 1462

"It has been suggested that the peaceful nuclear explosions should go on under international inspection * * *. In order to have an effective international inspection, it is necessary not only to have the explosion inspected, but to open up the explosive, look into it and see that it is an ordinary type of explosive. This could be done, but it certainly would give away a lot of information which at present is kept very closely guarded."

Comment

I would not advocate that the explosive be opened up. Such an arrangement would not put us at a relative disadvantage, and it would prevent the spread of nuclear weapons to smaller nations. It is true that then the "black box" might contain a new-type bomb which could aid weapons development, but we could do this too. Even if all nuclear explosions were stopped, this would not stop weapons development. In this sense a test-ban agreement is not true disarmament. But it could provide the very much needed first step toward disarmament and relaxation of tension. Furthermore it would entail setting up the much-needed inspection system inside the Soviet Union.

Page 1463

"If both of us would stop nuclear tests, then there is no doubt that through espionage the Russians would find out sooner or later what we know, and then we would have lost our last advantage. We can stay ahead only by moving ahead."

Comment

I believe the claim that Russia would catch up through espionage is an oversimplification. For example, Russia would have to test what she had learned through espionage.

Nowhere does Dr. Teller mention the possibility that Russia may eventually catch up to us and surpass us in weapons technology. Although, on the previous page he does say, "I believe that the Russians are developing their war machine faster than ours." I feel that it would be dangerous to subject the security of the United States to the philosophy, "We can stay ahead only by moving ahead." The Soviet Union is a bigger country than the United States. It has, or will have, more scientists and it is a dictatorship which can force its top scientists to work on nuclear weapons.

Page 1463

"This (stopping of tests) would leave the nonnuclear war machine of Russia free to take over the countries on the periphery of the Communist empire. I am sure that under those conditions Russia would, or rather the Communists would, conquer the world by thin slice and we could not do anything about it."

Comment

If India, for example, goes Communist, it won't be because the world stopped developing nuclear weapons. It would be due to the dissatisfaction of the Indian people with their Government and influence of the relative economic successes of Russia and China. Russia's next sputnik may well be the day when Soviet steel production exceeds that of the United States. I hope that day never comes; but now, with our production at 48 percent capacity, it is very close.

Page 1468

"To have an inspection about production of nuclear weapons is more difficult than to have an inspection of, let us say, machineguns or airplanes."

Comment

Our Columbia inspection study considers secret machinegun production much easier to hide than secret nuclear-weapons production.

Page 1480

"I don't think it (an agreement to ban all detectable tests) can be done, for this reason. Let us take just an example of underground shots. The question

is not whether an underground shot can be noticed. The question is whether it can be distinguished from an earthquake."

Comment

A detailed spelling out of the proposal to ban only detectable tests is that tests which would give seismic records below a certain amplitude would be permitted. The amplitude dividing line would be set at a level where explosions could be distinguished from earthquakes.

Pages 1480–1481

Concerning mobility of the inspection teams: "It would have to go on the spot, look around, find where the hole had been dug originally. Other surface effects would practically not exist. These holes could be camouflaged very easily. I think that inspection team would have an extremely difficult job. The only real way to check would be to bore in and find the radioactivity * * *. To try and bore and find the radioactivity would be a practically hopeless procedure."

Comment

The hole might be camouflaged easily, but not the road used to bring in the drilling equipment and used for earth removal. The bomb cavity could be pinpointed by seismic soundings. Then it would be simple to bore and find the radioactivity.

Page 1483

"I think that it would be reasonably safe for me to say that there are methods (of hiding tests) which are not so much in the technical field but which are certainly in the psychological field. The Russians might take one of these objects, put it on a submarine and then take appropriate measures, get their explosion off and then blame it on us."

Comment

The purpose of our proposed monitoring system is to detect violations. In the case of a test by a submarine, the U. N. inspection agency would immediately and conclusively know that the agreement had been clearly violated. If the United States and United Kingdom denied making the test, the overwhelming majority of the free world would believe them.

Page 1486

"Well, sir, let me perhaps tell you that detection is a field on which we have worked and worked and worked, and there was something on which to try it out. On hiding, we worked very little indeed. And I would like to hear somebody challenge that."

Comment

I doubt that we have worked very long on the central problem of how to distinguish an explosion from an earthquake. It is clear from the last two seismological conferences in the United States that we are just beginning to learn about this, and that there is much room for improvement. This is by far the key detection problem.

I hope the above partial analysis will help clear up some of the problems facing your committee. If I can be of any other help, please let me know.

Sincerely yours,

JAY OREAR.

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CONTROL AND REDUCTION OF ARMAMENTS

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HEARINGS

BEFORE A

SUBCOMMITTEE OF THE COMMITTEE ON FOREIGN RELATIONS UNITED STATES SENATE

EIGHTY-FIFTH CONGRESS

SECOND SESSION

PURSUANT TO

S. Res. 93, S. Res. 185, and S. Res. 286, 84th Cong., S. Res. 61, S. Res. 151, S. Res. 192, and S. Res. 241, 85th Cong.

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TO

PARTS 1–17

(HELD DURING THE 84TH AND 85TH CONGRESSES)

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INTRODUCTORY NOTE

This index supersedes that which was published in 1957. It covers all published hearings held by the Subcommittee on Disarmament through July 31, 1958. These hearings have been published in 17 parts as follows:

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Part 3.	March 7, 1956	Do.
Part 4.	March 15, 1956	Do.
Part 5.	April 9, 1956	Cambridge, Mass.
Part 6.	April 12, 1956	Washington, D. C.
Part 7.	June 7, 1956	Do.
Part 8.	June 8, 1956	Do.
Part 9.	June 16, 1956	Minneapolis, Minn.
Part 10.	December 12, 1956	St. Louis, Mo.
Part 11.	January 9–10, 1957	Washington, D. C.
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